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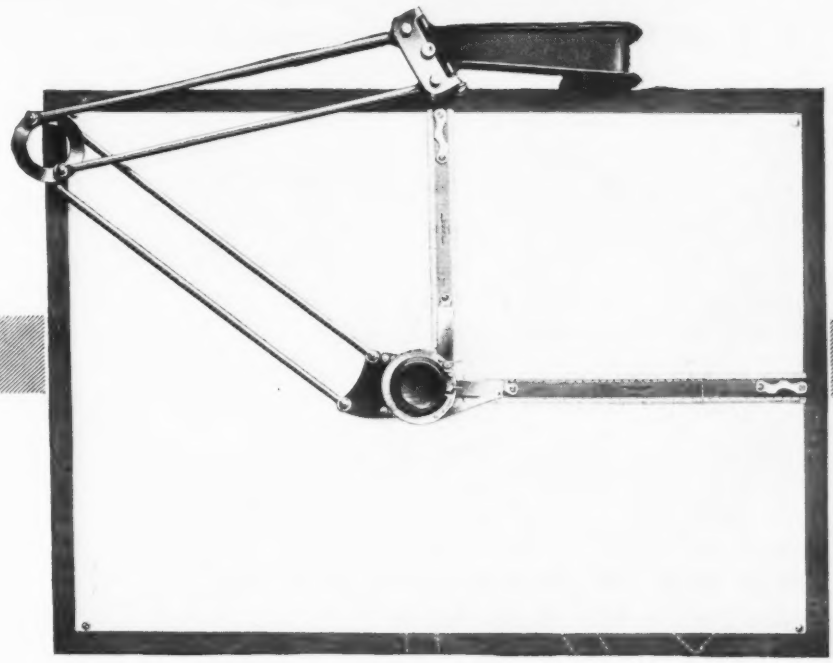

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More Lackawanna Steel Sheet Piling in United States Government Work

This time a cofferdam around the location of the upper guide wall at Lock C, Cumberland River, below Nashville, Tenn.

These pictures show the method of pile driving, and the two piling walls. 445 sections of Lackawanna Steel Sheet Piling in 25 and 30-foot lengths were driven here in 42 days and to an average penetration of 19 feet through sand and gravel.

The driving was accomplished from two towers supporting plank footways. From there, the men adjusted the hammer and piles, after the latter had been snaked from the top of the bank to the towers, by means of a separate block attached to the end of the boom from which the hammer was raised and lowered. This permitted a new pile to be swung into place as soon as the hammer was raised from the preceding one; the swinging pile being managed by a man on top of the bank, who, during the first part of the driving, was also used to steady and prevent any movement that might occur

by reason of the weight of the hammer when first placed. No leads were used during the driving, the hammer being allowed to rest vertically on the pile, being given its downward motion by slip in the engine drum, which worked very satisfactorily.

The second view shows the driving completed and the excavation and bracing begun in the upper end ofthe "hole," the dimensions of which when excavated to rock will be about 206 feet x 24 feet x 13 feet below water. The soil as removed was placed in front of the front line of piling to receive the thrust from the bank behind and was later covered with willows and riprap to prevent washing during the annual high waters which usually attain heights of from 30 to 40 feet above the front line.

The pile driving here was done by the Mansfield Engineering & Contracting Co., Indianapolis, contractors for the Government, and under the direction of Maj. H. Burgess, U.S.A., Government Engineer in charge, and Messrs A. T. Skene and C. S. Humberger, Supt. and Head Foreman respectively of the contracting company.

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Engineering News

CHARLES WHITING BAKER, *Editor*

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What The Buyer Needs To Know

Number Twenty-Four

You will be interested to know that the unwritten rules which have governed the advertising columns of all the Hill Publications have been formulated into an advertising code—a very definite code, to serve the interests of the three allied factors in any publication.

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Engineering News

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A Wooden Trestle Bridge Carried on Timber Beams

A remarkably unusual use of timber is represented by the bridge shown in the view herewith, a timber bridge on the Baker River & Shuksan R.R. across the Baker River, Wash., about 1½ miles above its mouth. The railway track here is about 180 ft. above the river. The bridge spans the gorge at about half the height to the track, by a combination of cantilever trusswork and 80-ft. beams, which, however, apparently acts as an arch; and on this bridge is erected a two-story trestle. Both upper and lower structures are built of round timber.

TRESTLE ON BEAM OR ARCH SPAN OF ROUND TIMBERS; BAKER RIVER & SHUKSAN R.R. CROSSING OVER BAKER RIVER, WASH.

The lower half, or base bridge, has a total length of 160 ft. The length of the central span or beam portion is about 80 ft. Bents of round logs were framed and set on suitably prepared abutments or footings near the bottom of the cañon, leaning at an angle outward from the vertical. At their tops they engage horizontal timbers running out from the bank. These bents were framed of 24-in. fir logs. The beams of the central span are 48-in. logs; they take the thrust of the inclined bents, and with them form an arch. The trestle resting on this lower bridge is of more ordinary proportions and construction.

In constructing this bridge, track was first laid on the railway grade to the bank of the river on the west side and bridge material was handled to the site over the track. All timbers used for the bridge were cut and framed in the woods close by, loaded directly onto log-

ging trucks and hauled to the site. Here they were lifted and set by a cableway spanning across the gorge on the center line of the bridge; this was operated by a hoisting engine at the east approach. The inclined bents of the lower part of the bridge were first set, being held in place temporarily by cables drawn across the river. The anchor timbers were next set in place. Then the 48-in. logs were laid to span the central opening, being dapped and bolted to the cantilevers.

This bridge was built as a temporary structure. When the time comes to replace it, it is to be used as falsework for the permanent bridge.

It is stated that the erection of the timberwork complete required only four weeks time after the foundations were ready. The erection was managed by J. MacBurney, who is given great credit for the efficient handling of the work.

The above data are from E. P. Lucas, General Manager of the Baker River & Shuksan R. R. (Concrete, Wash.), and A. S. Downey, Chief Engineer (Seattle).

Best Road Surfaces for Different Kinds of Traffic*

Experience in Massachusetts and elsewhere has shown conclusively that large numbers of swiftly moving automobiles cannot successfully be carried over a water-bound macadam road or over a gravel road. Such a road becomes raveled very rapidly, rutted and disintegrated. Traffic studies in Massachusetts indicate that from 50 to 100 automobiles a day make the use of some dust layer or binder necessary.

With the present motor-vehicle traffic it is necessary, where a road has heavy team traffic as well, to adopt in construction or resurfacing some form of bituminous mixture for at least the upper 2 or 3 in. of the road surface.

MOTOR-VEHICLE TRAFFIC ONLY—Some oiled gravel roads are satisfactory and very economical, if they are constantly and properly maintained, even where there are large numbers of swiftly moving automobiles a day, at least, in the summer months, but where there are not many heavily loaded wagons. Some of these roads have 500 automobiles or more a day, and yet they are cheaply built and cheaply maintained. Roads built of sand and asphaltic oil also stand up well under heavy motor-vehicle traffic, but these roads have very little heavy teaming on them. Heavy wagons and many heavy motor trucks rut such roads quickly and soon wear them out.

MAINTENANCE COSTS—When the motor vehicle appeared in fair numbers upon the roads Massachusetts had 600 to 700 miles of state highways (now, in 1912, over 900), and they were mostly water-bound macadam, with some few miles of gravel road.

These highways had been built from 1 to 14 years previously, very few miles had been resurfaced, and the Highway Commission had only $100 a mile a year to spend for maintenance and resurfacing, and not that much except for the last few years. The maintenance of these old roads was our problem in 1908, and has been ever since.

Automobile travel has increased 40% and the total traffic 14% a year, and these roads must be maintained, or the state's money, borrowed on long-time bonds, would be lost and wasted: the good roads would be gone, but the bonds would still remain to be paid.

The state doubled its appropriation for maintenance in 1908, giving the Highway Commission $200,000 a year instead of $100,000. The motor-vehicle fee was also increased, and the right to use the net fees for the maintenance of roads was obtained. These two sources of revenue for the last three years have provided about $500,000 a year, for maintenance; an average of $450 a mile a year, and we are at least holding our own.

BITUMINOUS BINDERS AND DUST LAYERS FOR OLD ROADS—Many miles of old roads have been saved by spreading a coat of asphaltic oil, light or heavy, or tar over them. Today some asphaltic binder or dust layer has been used on over 80% of our state highways. The only roads on which it has not been used are those located in the country districts where there is very light traffic.

This year (1912) we have used nearly 2,000,000 gal. of bituminous material in construction or maintenance. Over 800 of the 930 miles of our state highways have received some form of bituminous treatment. We have resurfaced as many miles of road every year as we could; using, where the traffic was heavy, a bituminous macadam on the top 3 in.

EFFECT OF TRAFFIC ON BITUMINOUS SURFACES—Massachusetts has four division engineers, on its highway work. They were asked the same questions relating to different tars, oils, asphalts, etc., and for their opinions of the relative merits or demerits of each.

The answers were all different. One had used tar on the surface successfully, another had not. One liked tar for penetration or mixing; another preferred an asphaltic compound. The same was true of the use of various asphaltic oils as a blanket coat, or as a dust-layer. One preferred a heavy cold oil, another a heavier hot oil. There was, however, if the traffic and other conditions in each case were carefully studied, a real agreement in all essentials.

WHERE HEAVY OILS FAIL—We have a good many miles of old macadam road which have been saved and maintained by ½ gal. of hot asphaltic oil spread upon each square yard of surface and properly covered with sand and pea stone or gravel. Many of these roads have worn three years, and in their fourth year are still in good condition. A few miles have worn four years and are now on their fifth year. The patching has cost but little, from 1 to 3c. per sq.yd. a year.

These roads often have very heavy automobile travel, possibly over 1000 cars a day. They often have large numbers of teams daily. One has over 500 teams and 1000 automobiles, and a heavy blanket oil surface has worn reasonably well for three years, and will for a fourth year except in a few places. This same road also has an average of 55 motor trucks a day.

Near two traffic taking stations, where the teaming was heavy, for one-quarter of a mile in each place (out of four miles), the blanket oil failed. It crumbled, went into mud, developed holes and was disappearing. We have replaced the top 3 in. with an asphaltic bituminous macadam.

HEAVY HORSE-DRAWN WAGONS CAUSE FAILURE—The traffic study shows that it is not the number of wagons, but heavy wagons—two or more horses and heavy loads on narrow tires—that cause the failure. The failure of roads treated with heavy oil has occurred on a few miles of road at certain places where it was clear that heavy horse-drawn wagons were responsible.

In two instances it was 50 to 75 ice-wagons a day, together with other wagons, carrying 3 tons or more each on 2½ to 3-in. tires which did the damage. In a month the oil surface began to crumble and break up on the side of the road on which the loaded teams traveled. The surface lasted three months on the other side of the road where these wagons came back empty. This same road, treated with the same oil, is still in good condition beyond the ice-houses. In one case for 3 miles, in the other for 15 or 16 miles, the oil surface is three years old and still needs only patching. Light cold oil has been substituted as a dust-layer and has proved reasonably satisfactory, though the stone of course is wearing out, and a bituminous macadam would probably prove economical.

In 1909 the Gloucester road, which had been covered with a hot oil blanket, was rutting and wearing out rapidly. A coal team was passing to some hotels three or four times a day during the summer (carrying 6 or 7 tons of coal on narrow tires). When a motor truck was substituted for the coal team the surface of the road, which had been oiled, was again in good condition. It has worn three years and now needs only patching.

HOT OIL BLANKET SURFACE—A hot oil blanket surface, made of a good asphaltic oil, will be economical and will carry large numbers of automobiles at high speeds (over 1000 a day in summer) for several years, will carry large numbers of light wagons (500 a day), and quite a number of motor trucks (50 or so a day), but will be destroyed by a large number of heavy wagons, especially those with narrow tires. Fifty or more such vehicles daily, farm wagons, wood wagons, etc., will rapidly destroy the road surface. A surface coat of a good quality of tar will last satisfactorily under a large amount of automobile travel, but usually it has to be renewed more often than a good quality of oil.

In all cases it is assumed that holes and depressions will be filled before tar or oil is used, that the bituminous material is evenly distributed and is sufficiently covered and kept so that it will not be picked up on tires, and that all holes that develop are patched at once as soon as they appear.

*Condensed from a paper on "Traffic Census of Roads in Massachusetts," by Wm. D. Sohier, Chairman of the Massachusetts Highway Commission, at the convention of the American Road Builders' Association, Dec. 5, 1912.

Constant repairs, at a cost of 1 to 2c. a sq.yd. a year will save an expenditure of from 40c. to $1 a sq.yd. for the resurfacing of these bituminous surfaces if they are allowed to go to pieces; and they will do it in a year or two at the most, if not cared for properly.

When these surface treatments fail, as they will where the traffic is extremely heavy (heavy in weight of vehicles, not numbers of vehicles) then some more permanent form of construction must be selected and the road reconstructed as soon as possible. It will prove to be true economy in the end, and the end is not far off.

Light cold oils, water-gas tar, etc., used as dust-layers help to prevent the raveling of roads. These materials may be economical and work satisfactorily for small wagon traffic (30 to 50 a day) and medium automobile traffic (50 to 100 a day), provided the road is not one where high speeds are usual.

They may also help to preserve the road from the effect of automobile traffic where the team traffic is too heavy, or the loads are carried on such narrow tires that a hot oil blanket surface will not wear satisfactorily, until money becomes available to resurface the top 3 in. with some form of bituminous macadam.

CONCLUSIONS SUMMARIZED—The accompanying table shows as nearly as possible the results observed after four years of experience with bituminous materials, comparing these results with the traffic going over the road in 1909 and again in 1912.

It is fully realized that more experience will undoubtedly cause changes or modifications in some of the present opinions.

TABLE SHOWING KINDS OF ROAD SURFACING BEST ADAPTED TO DIFFERENT CLASSES OF TRAFFIC FOR A STANDARD ROAD 15 FT. IN WIDTH, WITH A 3-FT. GRAVEL SHOULDER ON EACH SIDE

	Average Daily Traffic			
	Light wagons	Heavy wagons one horse	Heavy wagons 2 or more horses	Automobiles a day
A good gravel road will wear reasonably well and be economical with	50 to 75	25 to 30	10 to 12	100 to 150
Needs to be oiled with				over 150
Oiled gravel fairly good either hot or heavy cold oil ½ gal. coating (cold oil must be used yearly)	75 to 100	30 to 50	20	500 to 700
Water-bound macadam will stand with	100 to 150	175 to 200	60 to 80 Perhaps more	Not over 75 at high speed
Dust-layer will prove serviceable on such macadam with				50 to 100
Macadam will then stand (but the stone wears, of course), with				300 to 500
Water-bound macadam with hot oil blanket coat will be economical with	250 to 300	75 to 100	25 to 30	Up to 1400 and more with fewer teams
Will stand at least	50 motor trucks		probably more	
But will crumble and perhaps fail with over		100 on narrow tires	50	
	(loaded farm wagons, ice and wood wagons, etc.)			
Water-bound macadam with a good surface coating of tar will stand with	30 to 50	25 to 30	10 to 15	1800

The quality of gravel or other material and the speed of motor vehicles in particular localities are important factors and account for the above minimum and maximum variations.

It has not yet been satisfactorily determined when the weight of traffic makes it more economical to use a bituminous macadam, either tar or asphaltic products by penetration with a sealing coat of tar or asphalt, or by the mixing method, but it is believed that some such method would be economical and desirable where the team traffic is so heavy (75 to 100 heavy wagons on narrow tires with two or more horses), that a heavy, hot oil blanket surface will not carry the traffic but fails within the year.

We have several such bituminous macadam roads which have stood for three or four years very well indeed, but time alone will determine the ultimate economy. In surfacing with a 3-in. bituminous macadam top the extra cost for such top has varied from 30 to 60c. a sq.yd. depending on material and methods used.

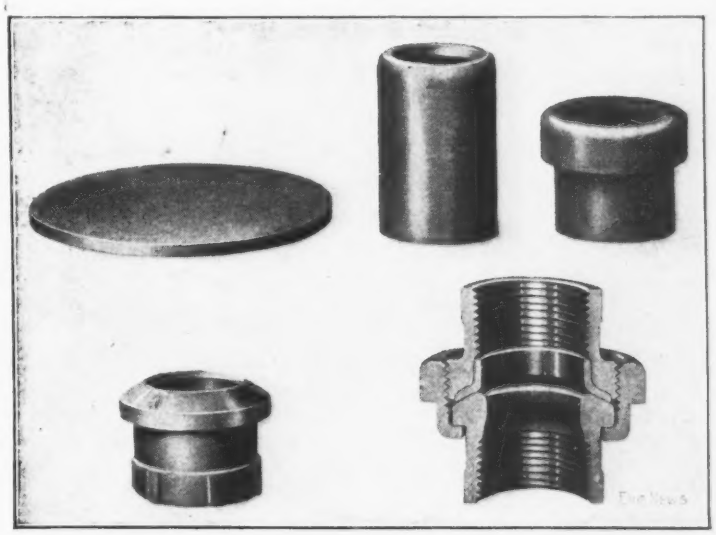
⁂

A State Insurance Fund for State Buildings in New Jersey was established by the legislature of 1913. The fund will eventually amount to $1,000,000, and as a beginning $50,000 has been appropriated for the purpose.

A Pressed-Steel Union Pipe Coupling

The accompanying figures show part of the process of making a pipe union which possesses radical features of novelty. This coupling is made of cold-pressed steel throughout, except for a soft-brass ring seat which is inserted in the female end.

This type of union has been designated with the idea of securing some physical advantages with decreased cost of production. Many union couplings, on account of lack of uniformity in the castings, have to be replaced in service—especially on high-pressure lines. Such unseen defects can hardly exist in a pressed fitting, since the production in itself is a test of the uniformity and quality of metal. By using the same material found in steel pipe, the expansion of the union under heat, is the



SECTION OF A PRESSED-STEEL PIPE UNION COUPLING AND FOUR STAGES IN FORMATION OF MALE END

same as the expansion of the joined pipes which very greatly reduces the tendency to stretch and to leak on contraction.

First, from steel strips are cut flat disks which are then pressed into deep cups with the bottoms punched out. One end of a cylinder thus formed is rolled back on itself and pressed into final shape with a finished seat (male end) or a head ready for threading (female end). The lower end is then upset to form a head and the part is complete except for setting the ring insert in the female end. This is drawn from soft brass and annealed after drawing. After threading, the steel parts are galvanized by the sherardizing process in which the articles are heated with zinc dust in a revolving drum.

The successive drawing operations noted are performed by a series of punch presses, ranging in weight up to 100 tons and driven by motors of 5 to 150 hp. The manufacturers are the Mark Manufacturing Co., of Chicago, Ill.

⁂

The Returns from Farm Animals on Irrigated Lands has been reported on by F. W. Hanna, of the U. S. Reclamation Service, and copies of the report have been sent out by F. H. Newell, director of the Service (Washington, D. C.), for the purpose of eliciting discussion. The subject is considered important to irrigation engineers because the permanent success of an irrigation project depends largely upon maintaining the fertility of the soil, toward which farm animals contribute in no small degree.

The Westchester Railway Electric Traction

SYNOPSIS—In a preceding article the lines and the stations of the New York, Westchester and Boston Ry. were pictured. The study of this interesting road is here continued with an outline of the electric-traction system including the overhead construction, the scheme of power distribution, the rolling stock and the switches and signals.

Overhead Construction

As the Westchester line is controlled by the New Haven road, it was only to have been expected that the 11,000-volt, single-phase system would be used. In fact the design and construction of the overhead structure were directly given over to the New Haven's electrical engineering department. Therefore, this work represents the latest development of the single-phase system, of which the New Haven has the largest example to be found yet. The new work shows, of course, many and great changes from the early New Haven installation (described in Engineering News, Sept. 5, 1907), the overhead contact system being very much simpler and more open, while continuity of service seems to have been increased, and first cost, maintenance expense, and general line troubles to have been reduced.

The supporting bridges for the overhead wires, of which a typical one for tangent stretches of track is shown in Fig. 1, are placed 300 ft. apart ordinarily. The design shown is a standard. For curves the spacing is reduced variously to a minimum of 200 ft., and heavier bridges are employed to care for the bending moments introduced in the legs by the pull-off of the suspended wires. There is one design for use on tangent, another for curves up to 4°. Where curves are sharper than 4°, a sufficient number of lattice-steel pull-

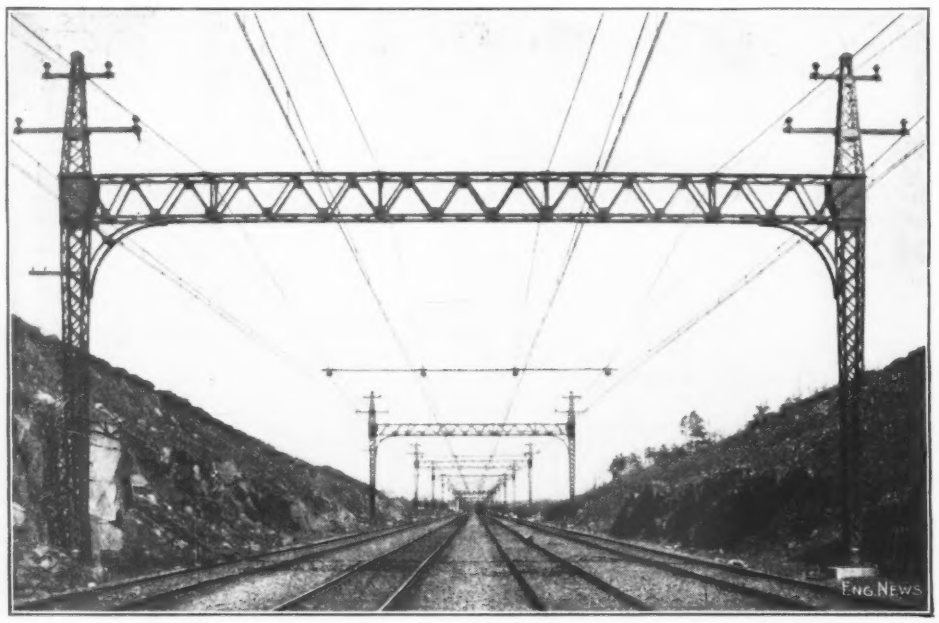


Fig. 1. Overhead Bridge for Tangent-Track Catenary Lines

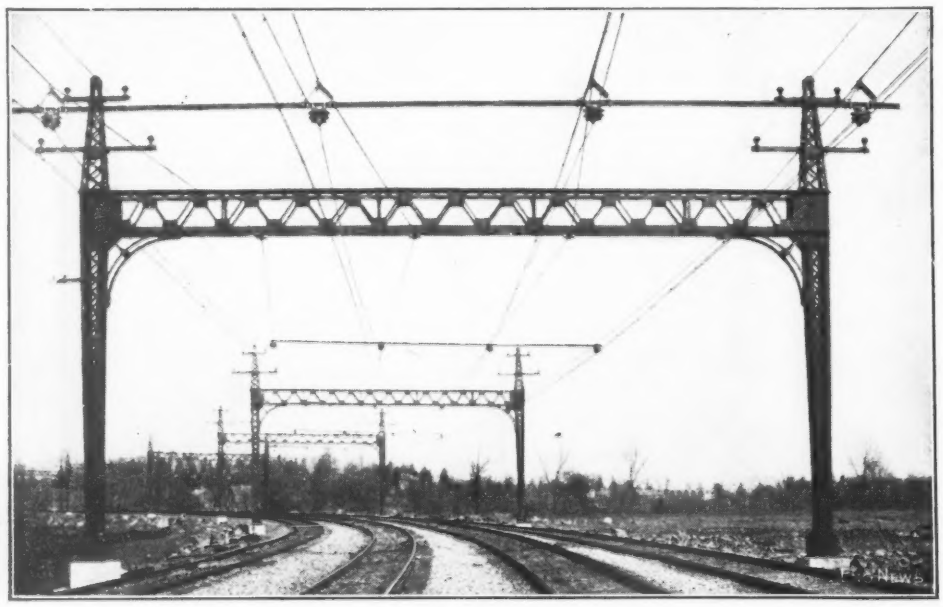


Fig. 2. Catenary Bridges at Track Curves

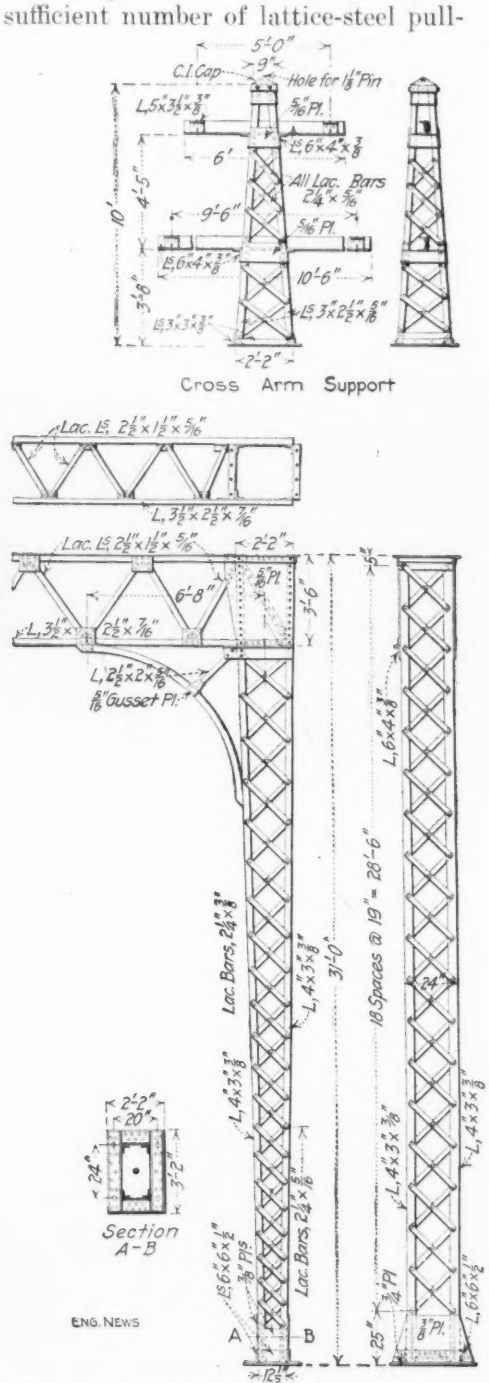


Fig. 3. Details of Tangent-Track Catenary Bridge

off poles are placed between the bridges to carry the extra side pull and to bring the conductor over the track center without awkward lengths of the catenary hangers.

In a few cases of station platforms, it is necessary to place the bridge columns between the outer and inner tracks to prevent extreme length of bridge girder, etc. In these cases, the outer catenaries are supported from cantilever ends of the girder as shown in Fig. 4.

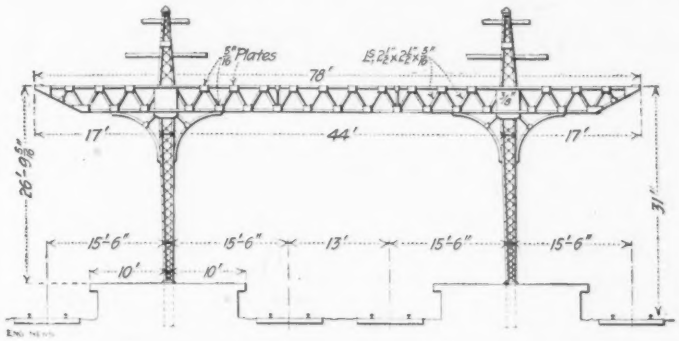


FIG. 4. CATENARY BRIDGE WITH CANTILEVER ENDS

On the four-track section, the main messenger cables (⅞-in. galvanized-steel strand) are fastened to saddles on top of the bridge girders. This cable is adjusted for a constant tension and variable sag. It carries none of the main-line current, being in contact with the bridges which are well grounded. Moreover, this construction gives a grounded overhead cage covering the contact conductors and protecting them from lightning.

In some cases the foundations for the bridges brought peculiar problems, as where the roadway was on a fill of considerable depth and it was desired to proceed with the foundations for the overhead construction before the fill could be allowed to settle. Where the height of the fill was considerable, a built-up arrangement of thick concrete slabs was used.

It was expected that in this way any disalignment of the foundation due to settlements could be compensated for by wedging up certain of the blocks of each foundation, and filling in with grout. Reinforced-concrete foundations were used to meet special conditions such as spanning station platforms, etc.

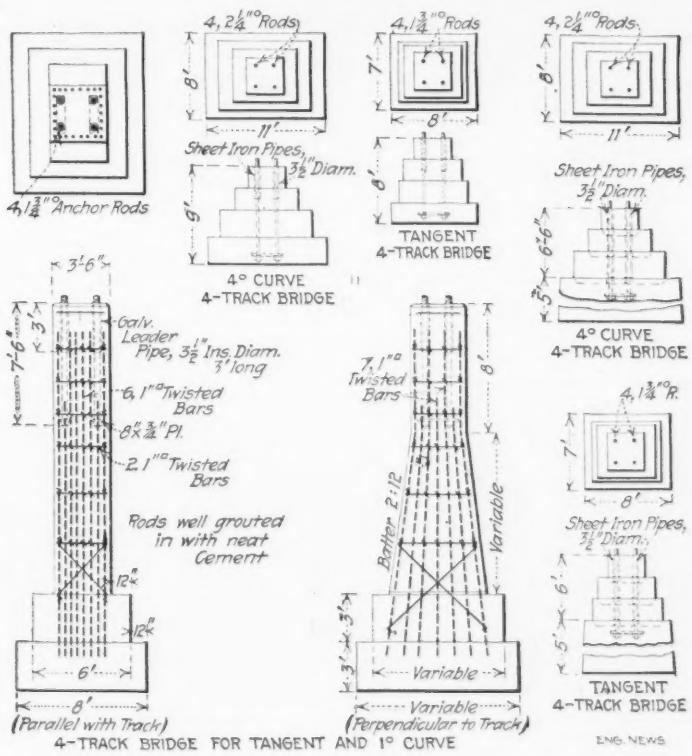

4, 2¼" ⌀ Rods
4, 1¾" ⌀ Anchor Rods
Sheet Iron Pipes, 3½" Diam.
4° CURVE 4-TRACK BRIDGE
4, 1¾" ⌀ Rods
TANGENT 4-TRACK BRIDGE
Galv. Leader Pipe, 3½" Ins. Diam. 3' long
6, 1" ⌀ Twisted Bars
8"x¾" Pl.
2, 1" ⌀ Twisted Bars
Rods well grouted in with neat Cement
7, 1" ⌀ Twisted Bars
Batter 2:12
Variable
(Parallel with Track)
(Perpendicular to Track)
4, 1¾" ⌀ R.
TANGENT 4-TRACK BRIDGE
4-TRACK BRIDGE FOR TANGENT AND 1° CURVE
ENG. NEWS

FIG. 5. A FEW CATENARY-BRIDGE FOUNDATIONS

The main catenary cable on normal spans carries a 3-in. I-beam at points 75 ft. out from each bridge (and therefore 150 ft. apart) spanning all four tracks (or both tracks on the White Plains branch). From these cross beams the intermediate catenary cable (⅝-in. galvanized-steel strand) is suspended by 110,000-volt-test porcelain insulators and this wire in turn holds up a No. 0000 grooved copper conductor with hangers 10 ft. apart, the length of the hanger rod being adjusted to make the copper wire parallel to the grade or to conform to such contour as is desired. Below the copper wire is a steel contact wire to take the wear of the locomotive-pantograph shoes. The wire is maintained parallel to the copper and 1¾ in. from it by spacing clips, also placed 10 ft. apart but midway between the catenary hangers to secure maximum flexibility.

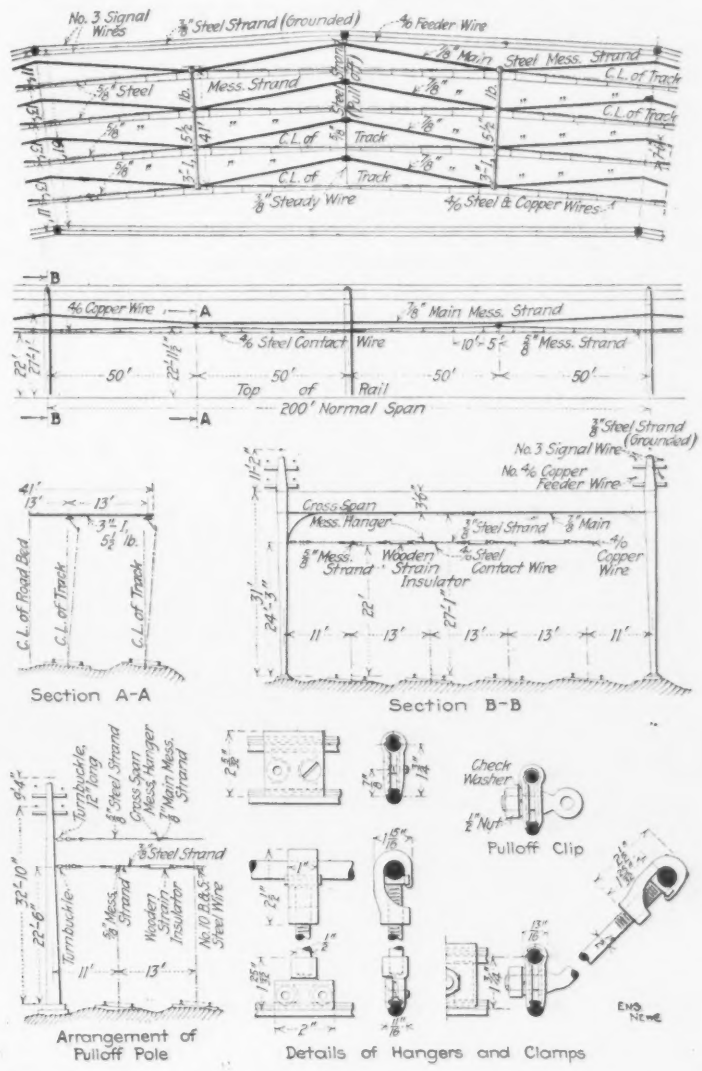


FIG. 6. NEW HAVEN 11,000-VOLT CATENARY CONSTRUCTION FOR CURVES

Where the sag varies, due to shortening up of the normal 300-ft. span, a T-section steel triangle is interposed between the main messenger cable and the crossbar, as seen in Fig. 2, to bring the crossbar to normal elevation. The same construction is found on some low bridge approaches and for the same reason.

The overhead wires have a novel appearance at curves

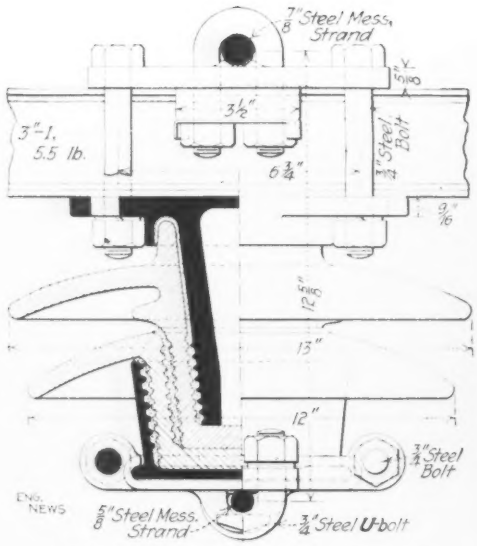


FIG. 7. DETAILS OF CATENARY INSULATOR

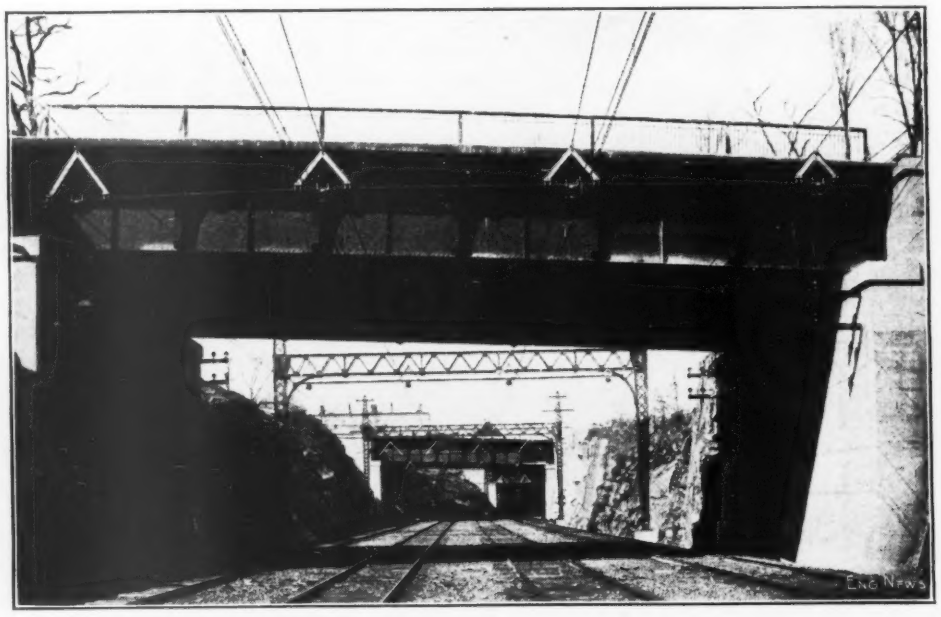


FIG. 8. LOW-BRIDGE CONSTRUCTION ON THE WESTCHESTER ROAD

due to the catenary hangers serving as both supports and pull-offs, and therefore being inclined to the vertical (28° for 1° curve, 48° for 2°, 58° for 3°, 63° for 4°). The proper length for these inclined rods in final position has been calculated for various curves. The catenary strand is installed with proper sag and the contact and copper wires are drawn up along the track to proper tension before the hangers are installed, when these lower wires have approximately the proper distance above the rails. The necessary flexibility is secured for easy underrunning of the locomotive pantograph by the inclined position of the hanger rod, there being a slight rotation about the secondary catenary cable support as the pantograph presses upward.

There are several low bridges on account of the grade eliminations. As shown in Figs. 8 and 9, the main cate-

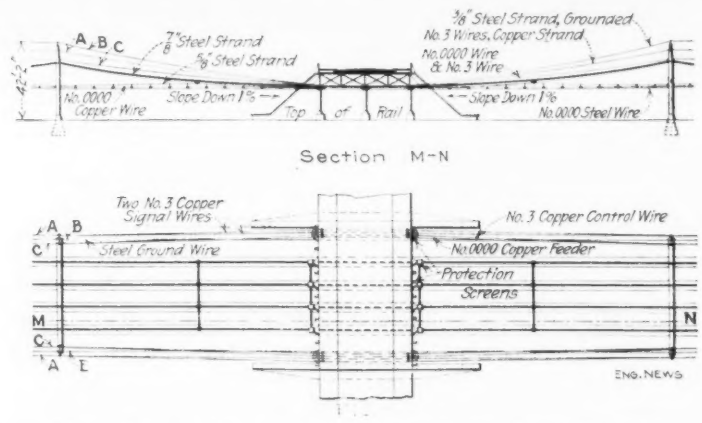


FIG. 9. PLAN AND ELEVATION OF LOW-BRIDGE CONSTRUCTION

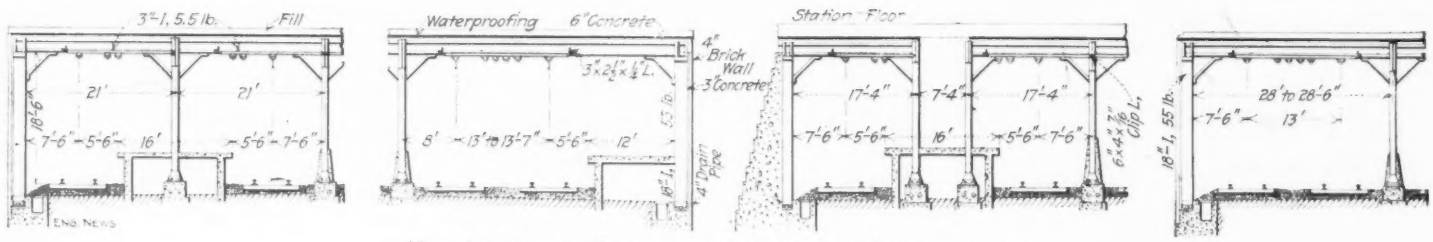


FIG. 10. CROSS-SECTIONS OF SUBWAY CONSTRUCTION

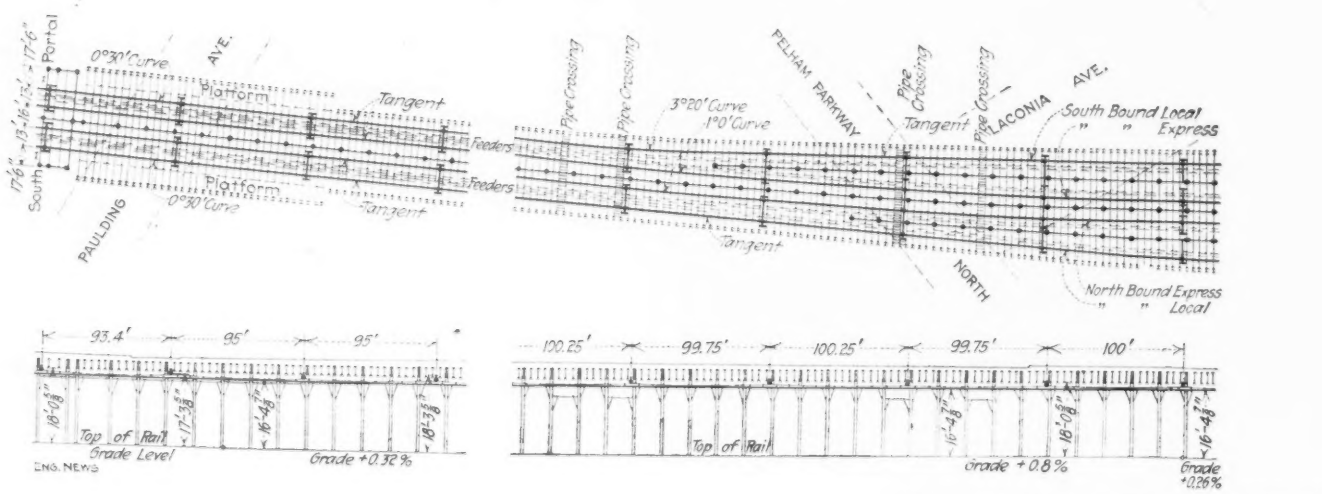


FIG. 11. PLAN AND ELEVATION OF

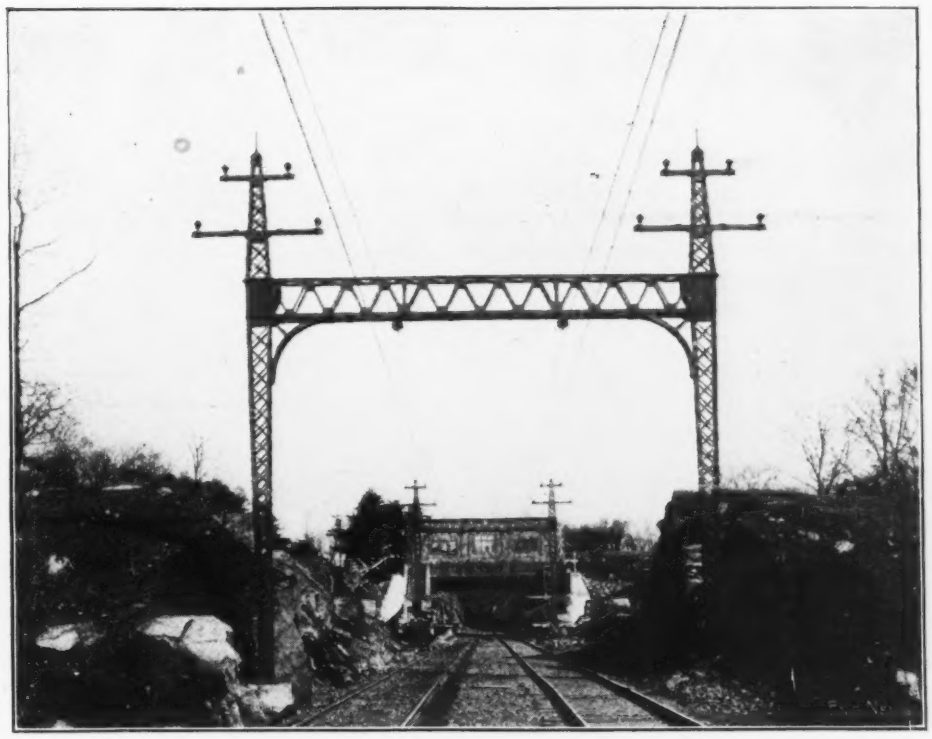


FIG. 12. SINGLE CATENARY ON TWO-TRACK LINE

nary cable is fastened to both end girders of the highway bridge; the copper and contact wires are supported in their usual way, but at two points only, and these outside the bridge.

A subway section of 3940 ft. has already been noted. The overhead construction is very simple here. The main catenary cables terminate at each portal, being securely anchored to the end girders. The standard form of insulator is attached to steelwork on the roof beams (which have a clear height of 18 ft. 5/8 in. above rails) and support the track catenary 16 ft. 4 7/8 in. clear above the rails. The copper and steel running wires are suspended from the messenger by standard hanger rods, and the usual spacing clips, as shown in Figs. 10 and 11. In the middle of the subway section is the Pelham Parkway station. The construction here is shown in Fig. 10.

A further simplification of the overhead construction was tried out on the New Rochelle branch (the double form already described was continued on the White Plains line, so that comparison should be later available). The intermediate catenary is omitted and a single cable (fastened to the under side of the bridge trusses) supports the copper conductor directly with the steel contact wire below the latter as before. The catenary cable has to be insulated from the bridges, in this construction, instead of being directly fastened thereto.

POWER SUPPLY AND DISTRIBUTION

Power (25 cycles, 11,000 volts, single phase) is taken from the plant of the New York, New Haven & Hartford R.R. at Cos Cob (which supplies the New York-terminal electric-traction zone of that road, and is equipped with three-phase generators carrying

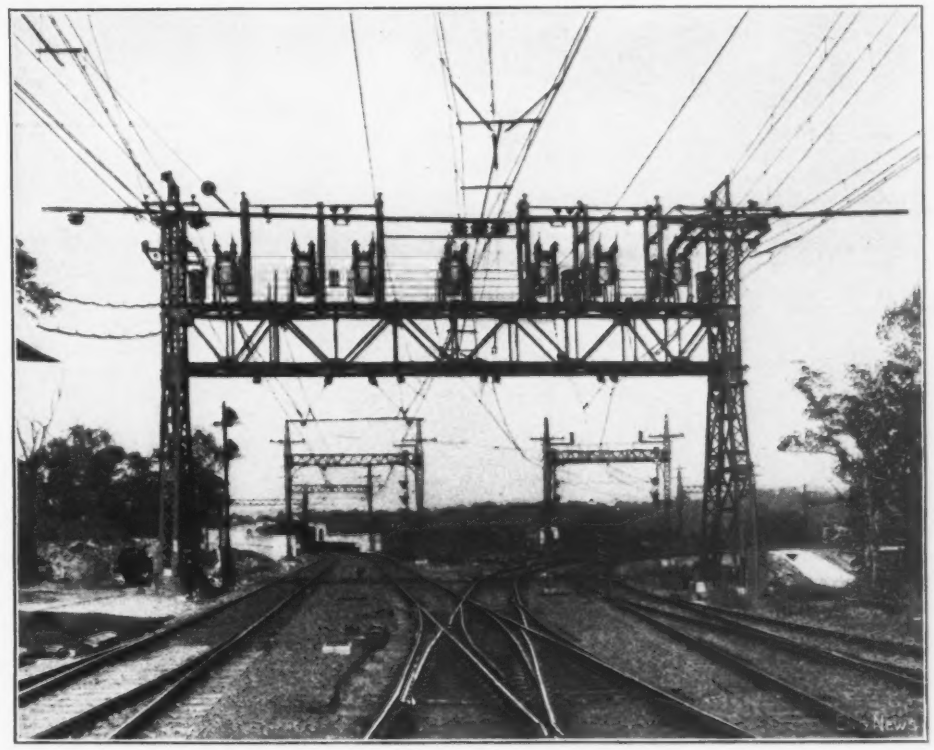
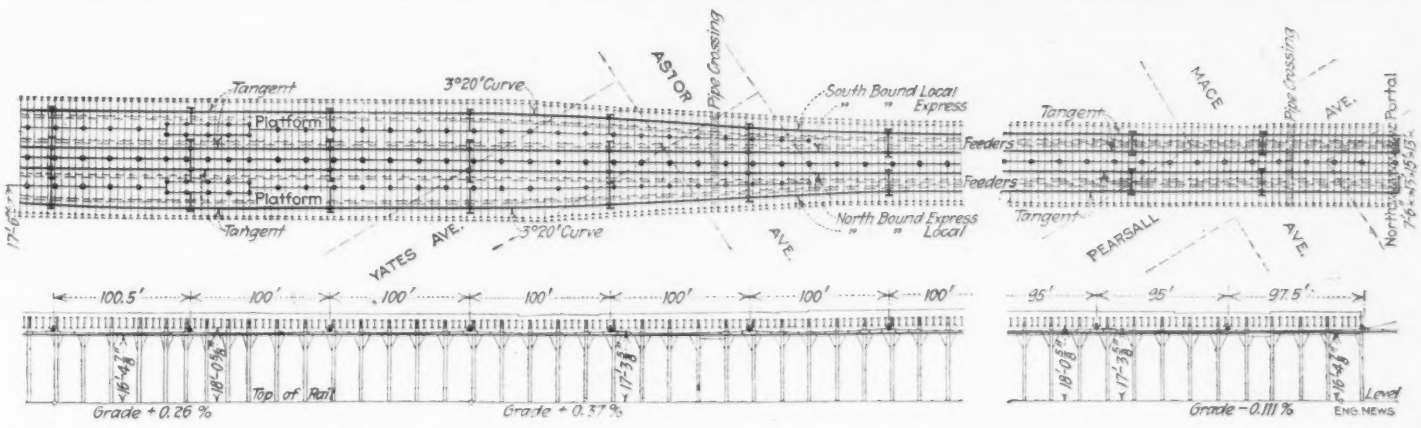


FIG. 13. JUNCTION OF TWO TWO-TRACK AND ONE FOUR-TRACK LINES



BRONX SUBWAY, N. Y., W. & B. RY.

elevator-motor and rotary converter loads on the three phases). A circuit diagram for the Westchester and New Haven combined system is shown in Fig. 14. Connection to the New Haven line is made at New Rochelle, Mt. Vernon and West Farms. The railway line is split into electrical sections between certain anchor bridges approximately 3 miles apart and the running conductors in these sections are connected together and to the feeder line through circuit-breakers as shown. The circuit-breakers, however, do not act directly on local overload, but are tripped from a control wire P_1, Fig. 14, which is energized by an overload relay at the Cos Cob station. The main overload relays here are so connected that the first action is to throw resistance into the main outgoing railway-phase feeder to limit the maximum short-circuit current and not to interrupt all traffic by every rush of energy.

As a circuit-breaker is allowed to open only by combined action of two relay coils, one carrying short-circuit current of the railway section in trouble, the other carrying control current from the power station, then only the circuit-breakers for the faulty conductor or section are thrown, and only after resistance has been inserted in the power-house circuit to reduce the short-circuit current to safe value for the breaker to open. The circuit-breakers, however, can be tripped from the signal towers in case of necessity for repairs or emergency action. In the circuit diagram (Fig. 14) one transformer is shown as connected to the automatic control wires, and having its secondary led to indeterminate circuits. It should be understood, however, that this secondary supplies all of the control coils on several circuit-breakers of that bridge. The same thing applies to the transformers for signal lamps and for the power for signal movements.

At present the main power distribution is at 11,000 volts, but soon this will be raised to 22,000 volts with 11,000 volts still on the contact wires. This is done by making the track-catenary connection to the feeders through an auto-transformer connected between the feeder and track circuit. The various stations are lighted from special transformers, the primaries of which are carried on the regulated railway phase of the power station, being connected between rails and the power-feeder wire A_1, Fig. 14. Where power for elevator or compressor motors, etc., is needed it is obtained (three-phase) from the feeders (F_1 and P_1, Fig. 14) and rails.

Rolling Stock

No locomotives are used for passenger service on this line; there is, however, one electric switch engine for pushing the motor cars into the inspection and repair shop, and for other odd jobs. For convenience in making line repairs, when voltage is off the system, a gasoline-electric work car is provided.

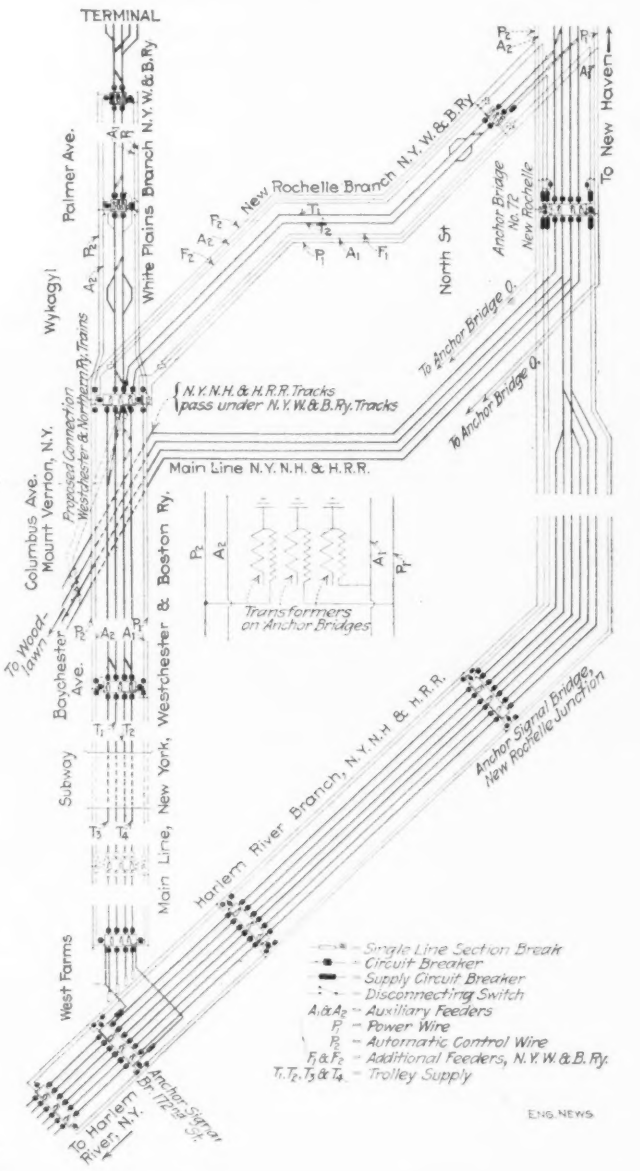

TERMINAL
Palmer Ave.
White Plains Branch N.Y.W.&B.Ry.
New Rochelle Branch N.Y.W.&B.Ry.
To New Haven
North St
Anchor Bridge No. 72 New Rochelle
To Anchor Bridge Q.
To Anchor Bridge Q.
Wykagyl
Columbus Ave.
Mount Vernon, N.Y.
Proposed Connection Westchester & Northern Ry. Trains
N.Y.N.H. & H.R.R. Tracks pass under N.Y.W.&B.Ry. Tracks
Main Line N.Y.N.H. & H.R.R.
Transformers on Anchor Bridges
To Woodlawn
Boychester Ave.
Subway
Main Line, New York, Westchester & Boston Ry.
Harlem River Branch, N.Y.N.H. & H.R.R.
Anchor Signal Bridge, New Rochelle Junction
West Farms
To Harlem River, N.Y.
Anchor Signal Bridge, 177th St.
Single Line Section Break
Circuit Breaker
Supply Circuit Breaker
Disconnecting Switch
A1 & A2 — Auxiliary Feeders
P1 — Power Wire
P2 — Automatic Control Wire
F1 & F2 — Additional Feeders, N.Y.W.&B.Ry.
T1, T2, T3 & T4 — Trolley Supply
ENG. NEWS

Fig. 14. Power-Supply Circuit Diagram of the New York, Westchester & Boston Ry.

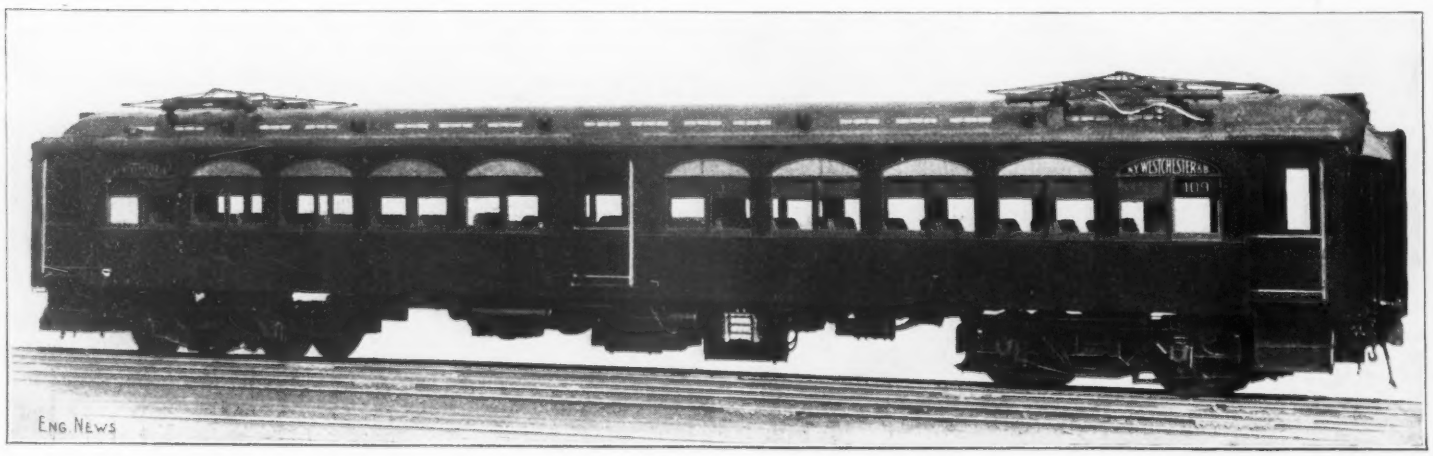


Fig. 15. Steel Car of the Westchester Road

The 30 passenger cars in service are all motor cars, each with a full complement of 11,000-volt apparatus on board. The bodies are 61 ft. 4 in. long, 9 ft. 8 in. wide, and 13 ft. 4 in. high; the length over buffers is 72 ft. ¾ in. Each ordinary car seats 78 passengers and weighs 120,000 lb. fully equipped. There are two 54-ft. combination cars with a 16-ft. compartment at one end for baggage.

The car-body design shows features of novelty and interest. It is virtually a development of the side-truss scheme worked out by the firm of L. B. Stillwell for the Hudson & Manhattan R.R. ("Hudson Tubes") tunnel equipment. The entire car sides of the latter are load-carrying members built up in truss form from rolled structural shapes. In the Westchester cars side trusses are built up from single-panel pressed-steel units in which the greater number of riveted joints are eliminated to give equal, or greater, and enduring rigidity with less

FIG. 16. INTERIOR OF WESTCHESTER CAR FRAME

weight. As shown in Figs. 16 and 17 the units are pressed with deep flanges from ¼-in. steel sheets and each comprises at once the outside plate of a post, the letter board and the diagonal braces below the windows. The units are riveted to a plate at the top, to the side sills at the bottom, and up the center to pressed channel shapes completing the posts which are 5 ft. 5⅝ in. apart. The window sills are formed by a light continuous double channel (UU) with a light channel intermediate post to the side sill.

By carrying the vertical load largely on the car sides, the center sills, needed to transmit buffing stresses directly from buffer to buffer, are practically undeflected and can be made light. They are held in alignment as columns under buffing compressions with the panels formed by cross and side sills (see Fig. 16). The roof framework is of pressed steel carlines riveted to the deck sills, which are carried on the bent-in ends of the side posts. In this way the designers place a structural cage about the passengers, which should furnish maximum protection against collision stresses.

The sides are sheathed with $\frac{1}{16}$-in. steel sheets, but these are not held in place by the frame rivets and carry no load stress. This construction presents some advantages by promoting ease of repair to damaged cars. It also appears that steel cars, which have the sheathing held merely as a curtain, are quieter than those where these sheets have to carry load, for which action various explanations are offered.

It is expected that this design will soon be employed by steam roads in metropolitan districts. One of the advantages of this type of car for suburban steam-railway service is its easy conversion to motor-car service

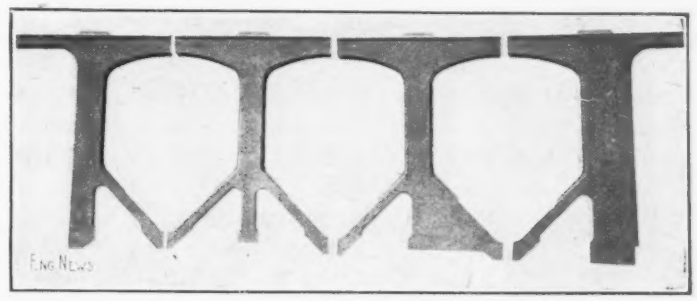


FIG. 17. PRESSED-STEEL UNITS FOR CAR-SIDE FRAME

under electric traction, as the shallow center sills not only do not interfere with use of large motors on the trucks, but also permit arranging the motive-power control equipment under the floor for maximum accessibility. This type of car is confidently expected by the designers to develop a useful life of such length as to bring it within a period when electric traction, according to the expectation of its leading exponents, would become an economic necessity for the suburban service out of large centers.

The motive-power equipment of the Westchester car involves the addition of about 25,000 lb. of apparatus per car. Equipped as a steam-road coach the Westchester design of car would weigh about 85,000 lb. and seat 88 passengers.

The Westchester car bodies carry the motive-power control equipment in three general lines along the center and side sills, so that the workmen in the inspection pit, can pass freely around all apparatus. (In the West-

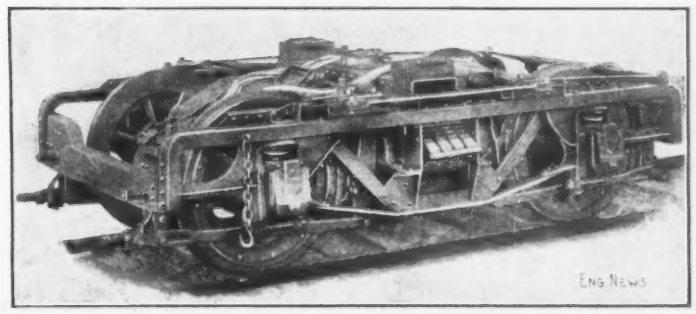


FIG. 18. MOTOR TRUCK, SHOWING CLASP BRAKE

chester inspection and repair shop, the pit tracks are carried on concrete piers to complete the accessibility. To facilitate inspection and cleaning, there are galleries in this shop at floor and deck levels. Three crews may work on a car at once.)

The cars have roof ventilating systems and electric heaters with thermostatic control. Special attention was given to heat insulation of the car exterior to prevent excessive loss of heat in cold weather. This is secured by use of a proprietary-insulation lining.

There are end and center side doors with pneumatic openers and electric control. While the station platforms of the Westchester line and the floors of these cars are on the same level, yet a flight of three steps has been built in each end vestibule, as the cars operate for some

distance over the Harlem branch of the New Haven road where low platforms are in use. These steps are covered with a trap door which is down at all the Westchester stations. The vestibules have the familiar Pullman end diaphragms to give a so called "solid train."

The car draft gear and buffing device are of standard steam-road type and have a capacity of 175,000 lb. The two motors are mounted on one truck, leaving the other an idler or trailer, for which smaller wheels and simplified construction are employed. The truck frame is made up of steel channels, angles, plates, and pressed shapes, with a few steel castings such as the journal pedestals and gussets.

On account of the high speeds and quick stops, a departure from the usual railway brake arrangements is seen. On the motor truck each wheel has two brake shoes after the style of the so called "clasp" brake. This was needed to reduce to a safe figure the energy dissipated at a single brake shoe. On the trailing trucks the ordinary type of brake rigging is employed. Separate cylinders work the brakes on each truck though a single control valve serves for both.

The entire system, including the air equipment, had to be designed for the peculiar demands of the proposed installation. In effect the standard form of electro-pneumatic control (see ENGINEERING NEWS, Feb. 29, 1912) was applied and adapted to the valve mechanism and auxiliary equipment developed for the heaviest steam-road equipment. It will be recalled that in this system the service and emergency applications are made truly simultaneous on all cars by electric control, although the old pneumatic control (serial) is still effective in case of failure of the electrical equipment. A 50-lb. service application of air is made from 70-lb. brake pressure. In emergencies the full reservoir pressure of 90 lb. is applied.

There is no auxiliary reservoir, however, and the old "triple valve" is replaced by a "control valve" serving the same purposes in somewhat simpler manner.

The arrangement of the brake rigging is diagrammatically shown in Fig. 19. All pulls are at right angles to lever members. The hand-brake rod and chain runs to a drum on a shaft carrying also a second (half-size) drum with a chain connected to an extension of the cylinder lever.

The motors are a single-phase series commutator type with a one-hour rating of 175 hp. (under forced ventilation), or 145 hp. continuous. The weight is in part directly on the truck axles, and partly supported through a nose suspension from a short three-leaf spring pocketed in the truck transom. Case-hardened solid gears were used for the most part, but on trial of a few flexible (spring bearing) gears favorable results were secured. In starting with the solid type, the pulsating torque of the single-phase motors produces considerable vibration throughout the car, but these vibrations are absorbed by the flexible gears.

On each platform is a small master controller with three running positions and three accelerating steps (for inserting resistance in the motor circuit). Acceleration of the trains at faster than a predetermined rate is prevented by an automatic-current limit switch which retards the successive step movements in the unit-switch group until the current for each step drops to proper value. The control also includes an overspeed switch which works the unit-switch group to reduce speed whenever a predetermined rate of 57 miles per hour is passed. This regulation is not effected directly, but the switch has (1) a current coil in series with one motor, and (2) a voltage coil connected across the armature of the motor. The two coils act differentially. When the combined effort of the current and voltage coils of the relay corresponding to a certain armature speed exceeds a definite value, then the unit-switch group will be manipulated to reduce the speed. The contactors of the multiple-unit group are thrown by compressed air from the brake system, but are released by current from a 32-volt storage battery floating on the direct-current circuit of a small motor-generator. A no-voltage relay opens the control circuit of the unit switches when line voltage comes off, in case the master controller is not changed before line voltage is restored, then the current-limit switch controls the succession of steps in the unit-switch groups and the rate of acceleration.

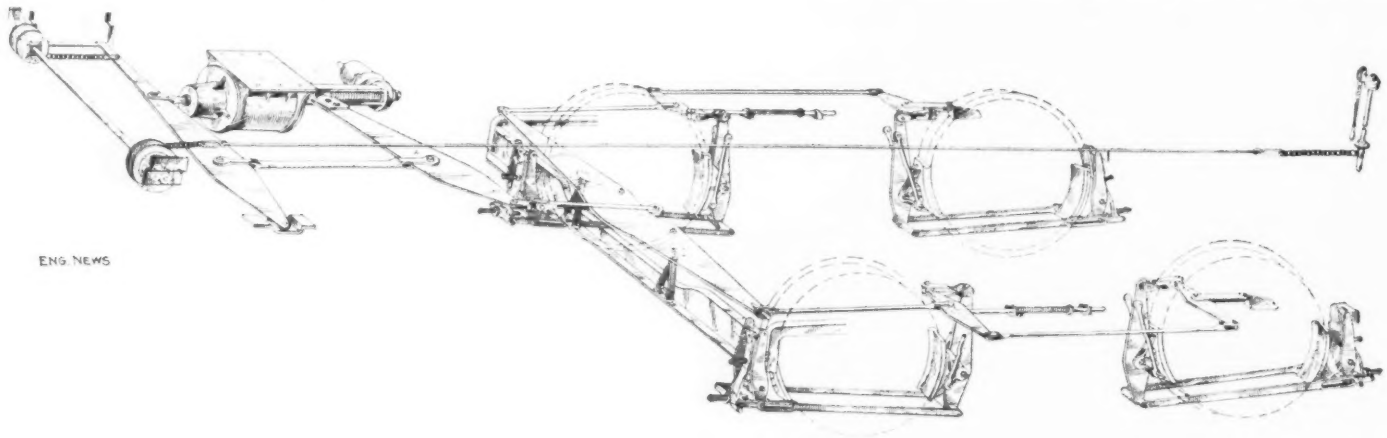


FIG. 19. DIAGRAMMATIC ARRANGEMENT OF WESTCHESTER CLASP BRAKE

SWITCHING AND SIGNALING EQUIPMENT

Automatic signals are used, the lines being divided up into sections about 4000 ft. long each, insulated from each other to permit the rails to be used for the signaling circuit. Both rails are used for propulsion and signal currents, as in the ordinary system. Novel features were introduced into this case by the use of 25-cycle propulsion current.

Sixty-cycle, single-phase current flows into the rails at the center of each block (Fig. 20). The power required per block for this service is some 0.1 kw. and the

current flowing through the track relay is about 4 amp. (at 3 volts); when a car or engine enters upon a block, its wheels in bridging the rails short circuit the track relays. These relays normally hold closed a circuit keeping the signal arms locked in "clear" position.

The insulating joints in both rails, at the end of each block, are bridged by impedance bonds which are installed in pairs as seen in Fig. 20. The arrangement shown is such that the full inductive impedance opposes the flow of the signaling current from one rail to the other and only a negligible amount passes. The bond as usual comprises a heavy coil wound about an iron core. The windings are of copper strap having a capacity of 200 amp. The bonds are immersed in transformer oil held in cast-iron cases which are set between the ties so as to be level with the top of the track ballast. Each pair of bonds is connected together at the center of the coils so that the railway propulsion current enters from both running rails and sets up opposing magnetic fields which neutralize each other, provided the current is equally distributed in the rails.. As the rail joints are staggered, one leg of the bond has to be extended (in buried wooden conduit) half a length to the nearest joint in the opposite rail.

A single track-supply transformer could be placed at one end of the block with a relay at the other, but wheels standing long at the feeding end would cause an unnecessary waste of power. Also, the voltage between rails at the relay end of the block might be so low that entering train wheels would not sufficiently short circuit the relay to hold the signal circuit at "danger." By center feeding with end relays, the 2000 ft. of rail interposed reduces the flow satisfactorily; there is small chance of wheels standing long in the middle of a block; and short circuiting of the rails is more certain.

The track relay is actuated solely by combination of signal and railway-propulsion currents; it is a vane type acting much like an induction wattmeter. There is an H-shape core with a double aluminum vane, moving in the air gaps between the arms, and pivoted so that it may oscillate through an angle of about 45°. The vane trunnions carry an arm which makes or breaks the desired connections. Copper bonds, acting as "shading" coils, inclose half of each pole-face area; on account of the alternating magnetic fields, induced currents are set up in them and the induced currents tend to hold the flux in the shaded part of the face. As a result, the relative intensity of flux is continually shifting between shaded and unshaded parts; this gives the effect of of progressively shifting field which would draw the vane arms after it. On one pair of arms, the pole faces are enlarged and a copper band encircles the pole, in addition to the half-pole-face band, and cuts down the flux of this arm below that in the undamped arms. The pull set up by signal current (60 cycles) alone is actually less here than that at the other end; if signal current alone passed through the relay, the leg of the aluminum vane between the small pole faces would be raised up. The choking is less effective on 25 cycles than on 60 cycles so that with propulsion current (25 cycles) flowing the difference between the pull on the vane in the two gaps would be less; the enlarged pole faces produce a greater effective pull than the smaller ones, so that the other side of the vane is pulled up when railway current alone is passing. When the relay is in normal operation, with signal current flowing through it, it will stand also from 9 to 12 amp. of railway propulsion current superimposed before it will change (sending signals to "danger"). This condition would arise only from a broken rail or open bond, in the track, when setting adverse signals is highly desirable. Beyond the relay there is less novelty seen in the signal equipment, except perhaps in the use of suspended center-pivoted two-position semaphore arms instead of the more familiar supported or mast type.

Where one signal has both home- and distant-indication arms a single motor moves either, in response to the proper impulses of the respective relays, as shown in Fig. 20. This design of semaphore has been widely used by the makers and is therefore but briefly described here.

Each semaphore has, in its base frame, one motor and an intermediate arrangement of apparatus to control the

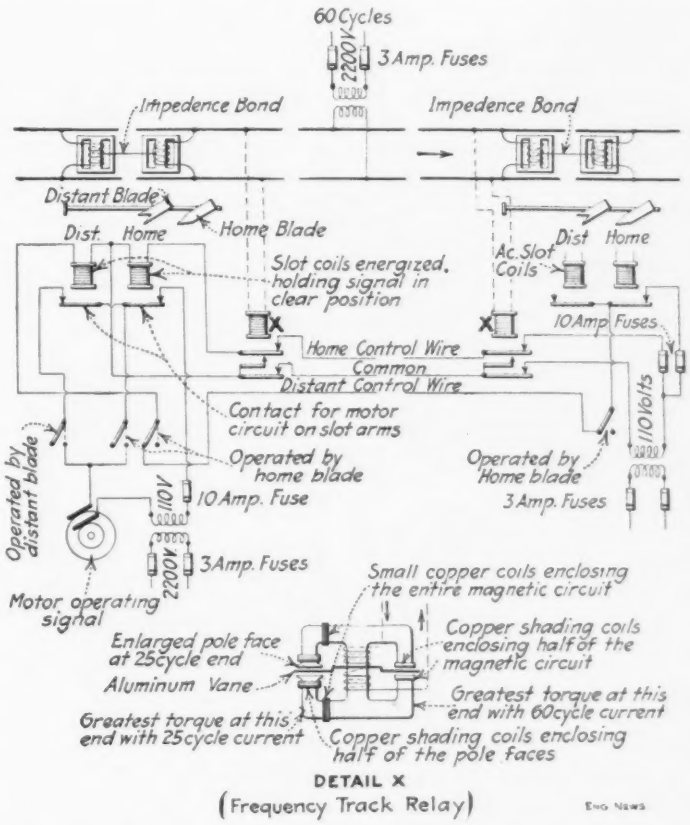


FIG. 20. DIAGRAM OF TRACK AND SIGNAL CIRCUIT, NEW YORK, WESTCHESTER & BOSTON RY.

position of the signal arm (which apparatus, in the development of the art of signaling, has universally come to be called the "slot mechanism" or "slot"). The motor drives a shaft carrying two endless chains, each carrying a pair of trunnions. The chains travel always in the same direction whenever the motor turns. The chain trunnion for either arm lifts a forked locked-toggle arm (the "slot arm") and through this a push rod which brings the semaphore arms to clear position. The slot arm is caught in this position by a hook latch; when the signal-current is withdrawn, the electromagnetic lock of the slot-arm toggle fails, the arm collapses and drops off from the latch hook, then the push rod and counterweight drop, bringing the arm to danger position.

The motors are a simple single-phase induction type starting automatically from any position and making a complete signal movement in four seconds.

As perhaps most of the signals on the Westchester line are suspended from the overhead bridges the above arrangement has to be changed—the long rod then reaching down from the slot instead of up to move the semaphore arm. In the subway section already noted the mast-type is used deprived of its arm and gives only the lamp indications.

The following cycle of operations begins after a train has passed out of a block (Fig. 20). Current flows through the relay to close the home-slot circuit and the slot magnet, acting as a relay, also closes the signal-motor circuit. The motor then raises the semaphore arm to clear position when the slot arm is latched there and the motor circuit opened automatically. The distant blade remains at "caution" until the train leaves the block ahead, when the home blade for that block then (in clearing) closes the distant slot circuit of the first signal so that the slot magnet (acting as a relay) starts the motor again to raise the distant arm. When this arm is raised and latched, the motor circuit is interrupted. It is seen that now both arms of the first signal mentioned are held clear by current through the track relays and slot magnets; when a train enters the block, both semaphore arms go to danger by loss of current through the track relays.

There are a few dwarf signals which are used for slow-speed train movement of reverse (from normal direction) traffic. These are a solenoid type, operated by direct current at 110 volts and controlled by an alternating-current relay (which replaces the slot magnets on the signals described).

Power for the signal and track circuits described is obtained from the main feeders which are carried along the right-of-way. A three-phase induction motor drives a 45-kw. single-phase generator to get the desired 60 cycles, to remove the peak of loads and to provide service when voltage may be off the signal-current feeders. A 70-hp. direct-current motor is connected to the same shaft and floats on a 400-amp.-hr. storage battery. When the three-phase power on the induction motor is interrupted the direct-current machine acts as a motor drawing energy from the storage battery. When three-phase current is uninterrupted, the conditions are reversed and the battery is recharged.

All-electric (direct-current) interlocking is used for the operation of the main-line track switches, there being seven interlocking plants. The most troublesome point in the train dispatching and routing is for the crossovers at the junction of the White Plains and New Rochelle branches in Mt. Vernon. It will be recalled from the previous article that the time tables are made up with the junction station here as a starting point, a local on one line meeting there with an express from the other but having to wait for the latter to clear the crossover and then to catch up with it on a parallel track.

As is usual, once a route has been indicated to an approaching train it cannot be changed for an interval of 1½ min., except in emergency when the switch release can be thrown so that the lever man can change the route, but breaking of the seals is necessary and requires an explanation to the signal engineer. Switches are unlocked as soon as a train passes.

Above each interlocking machine is a track model of the section governed by the machine, and for two blocks beyond the first home signal. Lamp indicators show then when the various signals may be cleared and when the switch locks are released, so that there is ample warning of routes which may be set up for approaching trains. The smaller of the interlocking plants do not have a man constantly in attendance and are arranged automatically to pass through trains.

In the interlocking equipment, only four wires run between the machine lever and the track switch (besides the direct-current supply mains). The track switches are motor driven (through a friction clutch and reduction gearing) with a horizontal drum operating the points. The motor armatures are connected permanently across the direct-current supply mains with current-limiting resistance and move the switches when current is sent through the field, the movement being controlled by direction of the field current. This is rather too heavy current to handle directly from the interlocking towers so an intermediate controller is set on a concrete foundation beside the switch (inclosed in a weatherproof case). This is itself a small motor with the armature permanently on the supply line and two field wires running to the machine lever. There are additional contacts on the controller to cause both ends of a crossover to move simultaneously. Two wires noted run from an indicating circuit to the indicator and lever lock on the machine. In the circuit controlled by the signal lever is a safety relay which can be energized only when the position of switch and lever correspond. Continuous current for operating switches and interlockings is furnished at each signal house by a small motor-generator set floating on a storage battery and receiving power from the signal feeders.

A very complete telephone system interconnects dispatchers, signal houses, and stations. The several circuits are assigned to various services and so connected that all important points can plug into at least two of them. The most important points can plug into any one of five different circuits, so that delays from broken wires are made remote.

One wire connects all signal houses on the four-track line and the New Rochelle branch. A second line connects all the interlocking towers on the four-track section and the White Plains branch. These two wires are for train control and may be handled together by one dispatcher, or separately by two dispatchers. A general-service wire connects all stations on the four-track section and the New Rochelle branch, and a second one connects all stations on the White Plains branch and the express stations of the four-track section. There is a wire for distance work between such points as signal houses, express stations, and terminals. There is also a local-service line between all the signal boxes by which the signalmen can intercommunicate without using a train wire. Finally there are duplicate wires all over the road to be substituted quickly for defective lines.

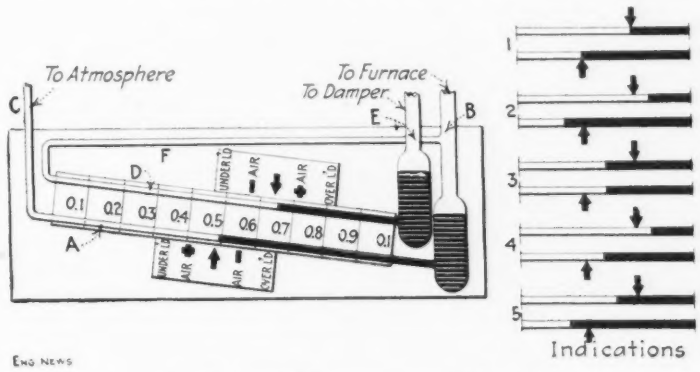
Inductive effects have not been serious. In addition to having the cables underground the lead sheaths are frequently grounded. There are static dischargers at each station and if all this proves insufficient, one pair of wires has been left to be connected to special transformers on the power lines to introduce differential currents in each cable opposing the disturbing impulses.

Construction is under E. J. Langford as chief engineer. Operation is directed by P. W. J. Smith, superintendent of operation: F. Zogbaum is engineer of maintenance.

The overhead construction work was under the supervision of E. H. McHenry, vice-president, and W. S. Murray, electrical engineer of the New York, New Haven & Hartford R.R., with P. J. Kearny, engineer in charge for the N. Y., W. & B. Ry. The rolling stock and shops were designed by the firm of L. B. Stillwell as consulting engineers.

A Boiler-Efficiency Indicator

One of the difficulties in insuring efficiency and economy of operation in large boiler plants is that of maintaining full boiler efficiency. Failure in this respect may result in excessive fuel consumption, a high degree of smoke, and irregular steam pressure. To maintain this efficiency it is necessary to keep the fireman informed as to the varying conditions, so that he may regulate his firing accordingly. While CO_2 recorders and steam-flow meters are valuable adjuncts for the operating engineer, they are expensive instruments and are not easily understood by the fireman. A device now being introduced indicates the conditions at each furnace in a graphic manner, for the guidance of the fireman. This device, shown in the cut, fulfills the purposes of the CO_2 recorder, the steam-flow meter and the draft gage. It may be fitted with an autographic recording attachment.



A Boiler-Efficiency Meter

Characteristic Indications

1. Normal operation of boiler.
2. Too much air, fuel bed too thin, or holes in fire.
3. Too little air, fuel bed too thick, or fire choked with slag.
4. Boiler running with overload.
5. Boiler running with underload.

The operation is based upon the relation of draft conditions to the efficiency of the boiler. The CO_2 content of the products of combustion is a good indication of the efficiency of combustion, but it gives no indication of the capacity developed by the boiler. The draft conditions, however, afford a direct indication of both efficiency and capacity. When a boiler is working at its normal capacity, a decrease in the normal draft resistance at the grate (due to a thin fire or to holes in the fire) will result in an increase in the drop of draft pressure through the boiler, and a consequent reduction in efficiency due to the excess supply of air. On the other hand, an increase in the normal resistance at the grate (due to heavy firing or failure to clean the grates) will result in a decrease in the drop of draft pressure through the boiler, and a consequent reduction in the capacity or rate of steaming. It results also in loss of furnace efficiency due to imperfect combustion.

The device mentioned above shows two things simultaneously in relation to the above conditions: (1) the draft or air pressure in the furnace; (2) the drop in draft pressure through the boiler, or between the furnace and the damper in the smoke flue. It consists essentially of a pair of draft gages, the indicating portion being a pair of inclined tubes in which the movements of a body of oil (colored for convenience) show the variations in draft. The construction is shown in the accompanying cut, and this part of the device is mounted in a convenient position in the boiler room.

The lower gage tube A has a ⅛-in. pipe connection B to the interior of the furnace, just above the fire level, while the pipe C, from its upper end, is open to the atmosphere. Thus the gage A gives a direct reading of the draft or air pressure in the furnace, and shows variations in pressure due to heavy, light or dirty fire. The upper gage tube D is in a closed loop; its lower end is connected to a pipe E leading to a point just inside the damper at the smoke flue or uptake. Its upper end is connected by a pipe F with the furnace tube B of the other gage. Thus the gage D is influenced by the pressure at the furnace and at the damper, and becomes a differential gage showing the drop in draft pressure between these points. A high reading on this gage indicates an excessive drop, meaning an excess of air, while a low reading indicates too low a drop, which results from an insufficient supply of air. The relations of the two gages indicate the causes of the defective conditions, some of which are indicated on the cut.

The gages are adjusted for each boiler. While the boiler is operating under normal conditions as to steam pressure, load and fire, the two lettered plates are shifted to bring the arrows at the positions indicated by the colored fluids in the tubes. They are then secured in position. In firing, the aim is to maintain the colored fluids in line with the respective arrows. This device is being introduced by W. A. Bloneck & Co., Fisher Building, Chicago, and is already in use in the boiler rooms of large office buildings and power stations, while it is being used also by the U. S. Navy Department.

Traffic Through the American and Canadian Canals at Sault Ste. Marie for the 1912 season is recorded as follows: The total freight traffic of both the American and Canadian Canals was 72,472,676 tons for the season of 1912, an increase of 36% over 1911. All items of freight show an increase when compared with the season of 1911, except coal, salt, copper and building stone. The total number of passengers was 66,877, a decrease of 13,074, and the passages through both canals numbered 22,778, a gain of 22% over 1911. Traffic through the American canal was 45% of the total freight, 55% of the total net registered tonnage, and 44% of the total number of passengers carried. Through the Canadian canal traffic was 55% of the total freight, 45% of the total registered tonnage, and 56% of the passengers carried.

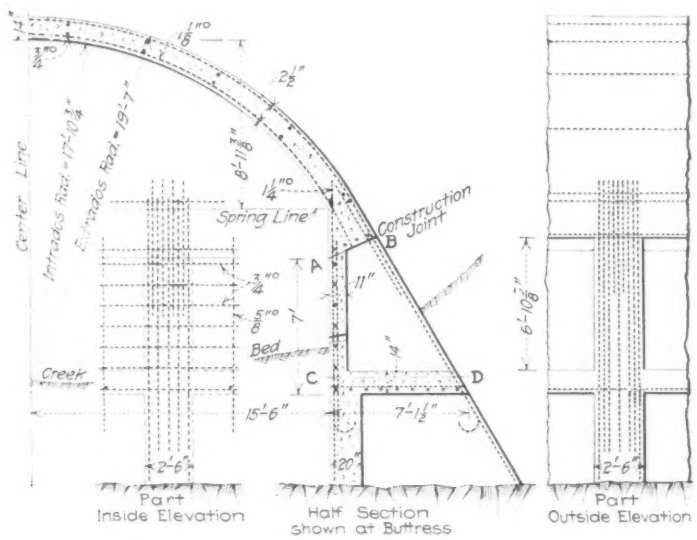
The Area and Mileage of Street Paving of various classes in the city of Philadelphia is given as follows in the annual report of the Bureau of Highways, of which Wm. H. Connell is Chief:

Character	Sq. yards	Miles
Granite block	6,653,532	352.99
Asphalt (sheet)	6,959,656	472.35
Asphalt (block)	72,532	7.49
Vitrified brick	2,376,224	163.63
Cobble	162,775	14.02
Rubble	93,182	6.69
Slag block	78,071	8.13
Cement and granolithic	54,242	11.03
Wood block	121,505	4.06
Totals	16,571,719	1,040.39
Bituminous macadam roads	312,104	29.01
Waterbound macadam roads	3,035,429	261.31
Total macadam roads	3,347,533	290.32
Grand total (improved pavements and macadam roads)	19,919,252	1,330.71
Earth roads	.....	179.06

Waterman Avenue Culvert, over River des Pères, St. Louis, Mo.

By Charles W. Martin*

The River des Pères, a natural drainage outlet for a large portion of the area of the City of St. Louis, as well as a part of St. Louis County, crosses a number of streets in the western portion of the city. The rapid growth of this section of the city has necessitated the construction of a sanitary sewer below the creek-bed level and there is now need of a storm-water sewer of sufficient capacity to care for the runoff of the drainage area. Preliminary to this sewer construction and as a step toward the betterment of traffic conditions in this district two



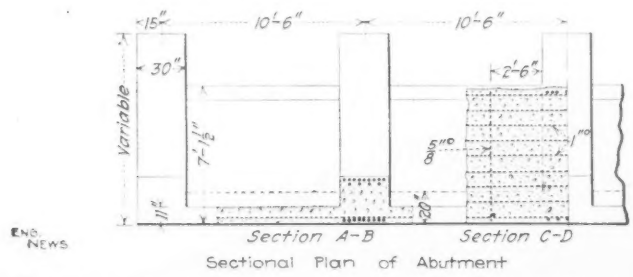


Fig. 1. Details of Arch Culvert across River Des Pères, Waterman Ave., St. Louis, Mo.

culverts have been constructed by the City, one at Waterman Ave. and one at Kingsbury Ave. Both culverts are in general, of the same design and it is intended that they may later become units of the proposed storm-water sewer. A description of the design and construction features of the Waterman Ave. culvert is given below.

The structure (Fig. 1) consists essentially of a reinforced-concrete arch, 76 ft. in length, with rubble masonry end and wing walls, retaining the roadway embankment. The arch span is 31 ft. and subtends a circular arc of 120°. The thickness of concrete at the crown and spring line is 14 and 17 in. respectively. The tranverse reinforcement for the intrados and extrados of the arch barrel consists of a system of 1-in.- and 1⅛-in. round rods spaced, in general, at 8-in. centers. Near the spring line the intrados face is further reinforced with a system of 1-in. bars, making the spacing of bars in that region 4-in. centers. This reinforcement extends 2½ ft. below the spring line into a trapezoidal-sectioned skewback which is cast as an integral part of the arch and designed to act somewhat in the nature of a beam in transferring the arch-ring thrust and moment into the buttresses of the abutments. Each skewback is reinforced longitudinally with four 1⅛-in. bars which together with a system of ¾-in. bars, spaced from 4 to 1½-ft. centers, in each face of the arch constitute the longitudinal reinforcement of the arch barrel.

The buttresses are the primary structural elements of the abutments. They are 30 in. wide, spaced 10 ft. 6 in. centers and extend to bedrock, which is at a depth of 8½ ft. below the creek bed or about 17 ft. below the spring line of the arch barrel. The face plane of the buttresses is vertical while the back is made tangential to the extrados of the arch at the spring line. The front and back faces of the buttresses are reinforced with 1¼-in. bars. All of these bars extend upward from 30 to 40 in. above the longitudinal construction joint between the abutments and the arch-barrel skewback. Horizontal diaphragms 14 in. thick extend between buttresses at about the elevation of the creek bed. Above and below the horizontal diaphragms 11- and 20-in. face walls divide the abutment structure into a system of cells.

The horizontal diaphragms are reinforced, in the bottom face, by a system of 1-in. longitudinal bars with ⅝-in. bars transversely. They are designed to assist, by transferring the weight of their superimposed embankment to the buttresses, in limiting the range of application of the force resultants to the mid one-third of the rock-bearing area of the buttresses.

The end and wing walls are of rubble masonry, roughly coursed, with concrete copings (Fig. 2). The height of end walls is two feet above the arch crown. They were designed to retain, at a 1 on 1½ slope, an embankment of 5½-ft. height over the arch crown and 46-ft. width. Adjacent to the abutments the end walls extend to the elevation of the horizontal diaphragm but are stepped

Fig. 2. View of Waterman Ave. Culvert

[Railing and street surface yet to be placed]

up the creek embankments. The wing walls are built to retain the run-around embankment slope from the end walls and were carried to a depth of four feet below the creek bed. It is intended to protect them with rip-rap.

The backs of the arch barrel and walls were painted with asphalt. Weep holes, 3 in. in diameter, through the face-wall concrete at each bay of the cellular abutments provide outlets for seepage. At these points clay backfilling was rammed to such slope and stones piled as to facilitate drainage.

*Street Department, St. Louis, Mo., 6173 Berlin Ave.

In addition to the backfill loading, the arch structure was designed for a live load of 100 lb. per sq.ft. of roadway surface, which together with the influence of distortions in the structure resulting from a considered nominal change of temperature of 20° F., either way, in the arch-ring concrete, develop figured maximum stresses of 800 lb. compression per sq.in. in the concrete and 8000 lb. tension per sq.in. in the steel reinforcement. These maximum stresses obtain at the junction of the arch barrel and buttresses. In the horizontal diaphragms and face walls, however, simple beam action was assumed and the unit stress in the steel figured at 18,000 lb. per sq.in.

The construction features are not of special interest. Excavation was, in general, executed by hand. The concrete was machine mixed at a plant situated at the top of the creek bank and was conveyed to the abutment forms through chutes and to the arch forms in end-dump hand carts. The arch-barrel forms consisted of a 2-in. dressed and matched longitudinal sheathing supported by trusses of 30-ft. span spaced at 4-ft. centers transversely which, in turn, were supported by posts extending to rock. These posts, in place, were also used as studding for the abutment face wall forms. Forms for the extrados of the arch were constructed in "two-man" sized units and placed as the arch-barrel concrete progressed.

The material and proportions, by volume used in the concrete mixture were: One part "city tested" portland cement; two parts sand and four parts washed gravel graded in size from ½ to 1½ in. Tests indicated an average percentage of voids in the gravel of 41%. Plain, round bars rerolled from rail steel were used for all reinforcement.

The abutments were constructed as single units up to the skewback bearing. The arch barrel was poured in three sections. For each section the concrete was brought up simultaneously from each side and completed in one continuous run of the mixer.

The quantities and unit prices bid by the contractor for constructing the reinforced-concrete abutments and arch barrel and the masonry end and wing walls are as follows:

Item	Quantity	Unit price
Excavation	15,100 cu.ft.	$0.07
Concrete	11,300 cu.ft.	$0.34
Rubble masonry	8,050 cu.ft.	$0.20
Steel reinforcement	65,800 lb.	$0.0325

This makes the cost per lineal foot of culvert, without the masonry walls, approximately $93 and the total cost of the structure complete, save the embankment and surface improvements, approximately $8650.

Clay from excavations for neighboring buildings and ashes, hauled by the city, were used as backfilling. The maintenance of the dump only is chargable to the improvement and for that 3500 cu.yd. of filling required amounted to approximately $750.

During the construction the weather was unusually favorable and it is believed that the contractor made a fair profit on this culvert. Regarding the Kingsbury Ave. culvert, which was later also constructed under the one contract, the same can not be said.

The tributary drainage area of River des Pères, above these culverts, is approximately 10,500 acres, most of which lies in undeveloped districts. Its flood carrying capacity was put to test by a rainfall of 3.6 in. on Mar. 25 last, which had been preceded by rainfalls of 0.73 and 0.68 in. on the 23d and 24th respectively. The maximum rates of fall in inches per hour were, for a 10-min. and 1-hr. period, respectively 1.44 and 0.68. At Waterman Ave. the flood water level rose to a point a few inches above the sping line of the culvert arch barrel. While the intensity of this storm was not more than, say, 60% of a probable maximum, it was as intense as storms to be expected with any frequence.

L. R. Bowen, is Bridge Engineer for the City. Heman Construction Co. was the contractor. The writer designed the structures and had charge, in the field, of the construction at Waterman Ave. L. B. Vella was in charge, in the field, at Kingsbury Ave.

A Draftsman's Details

By A. T. N.

Oh what a life
The draftsman leads,
In this old world today;
He draws his plans,
He draws his breath,
He draws also his pay.
His weary hours
Are long-drawn out,
While waiting for a "raise";
His wrinkled brow
Is drawn down more,
No increase meets his gaze.
He fills his pen,
Then draws a line,
And mutters "Things ain't square,
I think I'll chuck
This bloomin' job
For one with more fresh air.
I glue my nose
Down to my board
The bloomin' live-long day;
The bloomin' boss
Is standing near,
To see I earn my pay!
The boss, he thinks
I ought to know
All things from A to Z,
And still be glad
To work for him
At what he now pays me.
This drafting life
Is 'on the Fritz,'
It surely makes me 'sore!!' "
He "beats it" home
But in the morn'
He comes right back for more.

A Liquid Rheostat for large alternating-current motors has recently been developed by the Westinghouse Electric & Manufacturing Co., to supply the demand brought by the use of large slip-ring motors driving mine hoists, winding gears, rolling mills, etc. Such a rheostat provides an infinite number of speed steps between limits and permits smooth acceleration. This particular design comprises two compartments, an upper tank for immersing the electrodes and a lower storage reservoir. The small motor-driven pump maintains a steady stream of liquid, usually an alkaline solution, from the lower reservoir into the upper tank, the latter discharging its contents back into the former over a weir, which takes the form of a tube that can be raised or lowered through the floor of the electrode tank. By raising or lowering the weir the height of liquid in the electrode tank is varied and resistance between electrodes changed as desired. The operating lever of the rheostat controls both the weir and a master switch, which opens and closes the primary circuit of the motor. A valve in the intake pipe of the electrode tanks regulates the rate at which the liquid can be pumped in, so that no matter how quickly the operating arm is thrown over the liquid can rise in the tank only at a definite rate, thus fixing the rate of acceleration. Cooling coils for circulation of water, are introduced in the lower reservoir to prevent overheating and rapid evaporation. The capacities so far designed are from 400 to 1500 hp. of controlled motor.

The Morena Rock-Fill Dam, California

SYNOPSIS—The Morena rock-fill dam extends 150 ft. above the natural bed of Cottonwood Creek and has a concrete toe wall on the upstream side which goes down 112 ft. below the stream bed. The whole structure, including a 3-ft. concrete coping-wall, is 265 ft. high. The rock in the upstream portion of the dam proper was laid by hand and by derrick, and was faced with rubble masonry in cement for watertightness, except that for the lower 30 ft. the same end was achieved by an extension upwards of the 112-ft. concrete wall already mentioned. Above this concrete toe wall reinforced-concrete slabs extend 12 ft. or to Elev. 42 above the stream bed. The upper portion of the wet slope is also protected by a layer of reinforced concrete. The dam is 505 ft. long on top, 300 ft. thick or wide at the base and 16 ft. wide at the top. It contains 306,000 cu.yd. of material and cost $1,100,000, including a circular concrete tower 155.5 ft. high, with outlets at various levels.

❋

The Morena Dam is one of four (a fifth is projected) built by the Southern California Mountain Water Co. to supply San Diego and Coronado with water for municipal purposes. Eventually water will also be furnished for irrigation. The first dam (the Lower Otay) was begun in 1887. The Morena Dam was put under construction in 1896, but work was suspended in 1898 as stated further on.*

We have received from M. M. O'Shaughnessy, chief engineer of the Southern California Mountain Water Co. for a number of years (now city engineer of San Francisco), a set of blueprints and a number of fine photographs of the Morena Dam, which we reproduce herewith. The text of this article is based upon or quoted from a paper by Mr. O'Shaughnessy entitled "Construction of the Morena Rock-Fill Dam, San Diego County, California," presented at the meeting of the American Society of Civil Engineers, Dec. 20, 1911, and reprinted from the Transactions of that Society, Vol. LXXV, pp. 27 *et. seq.* (1912). In closing (by letter) the discussion on his paper Mr. O'Shaughnessy gave some additional information, parts of which we incorporate, in brackets, in their natural position in Mr. O'Shaughnessy's original paper.

Before taking up Mr. O'Shaughnessy's description of the Morena Dam a few facts regarding the larger works of which they form a part may be given.

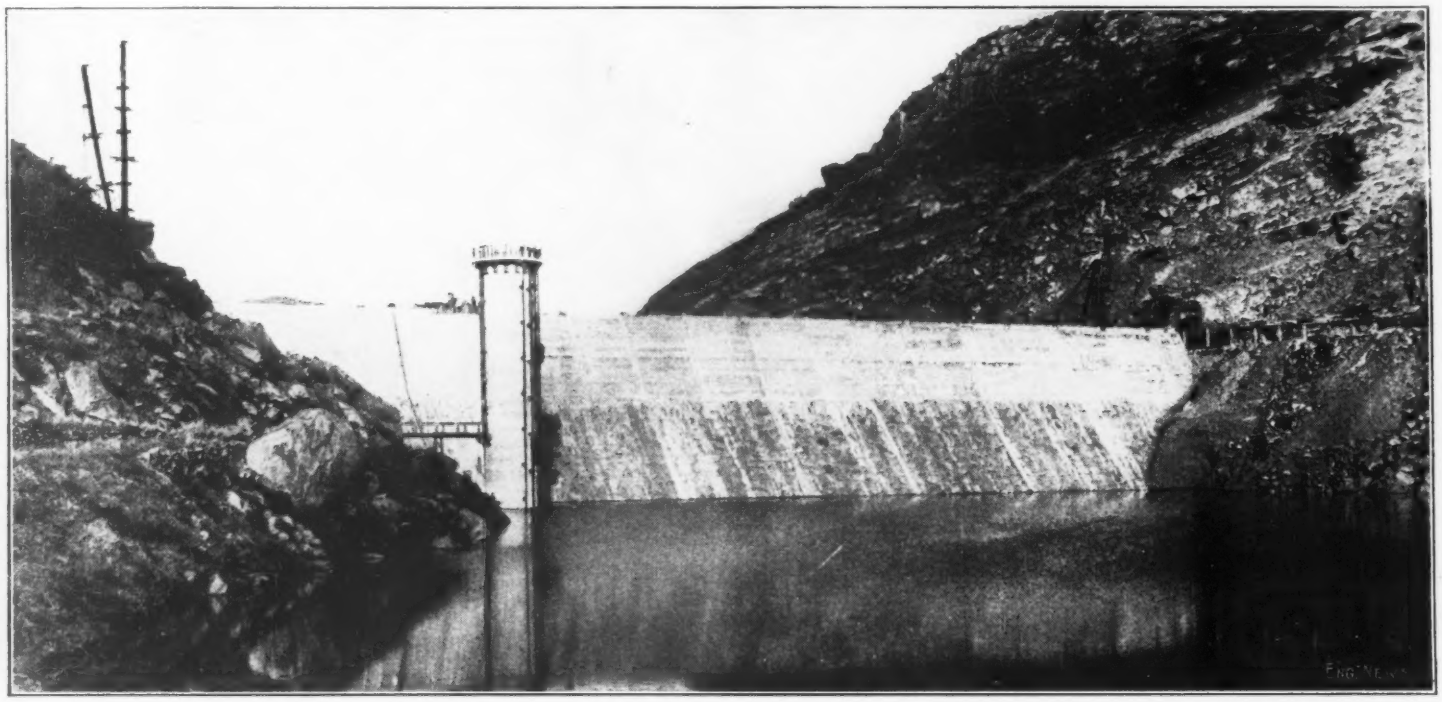


FIG. 1. GENERAL VIEW OF MORENA ROCK-FILL DAM, SAN DIEGO COUNTY, CALIF., LOOKING NORTHWEST

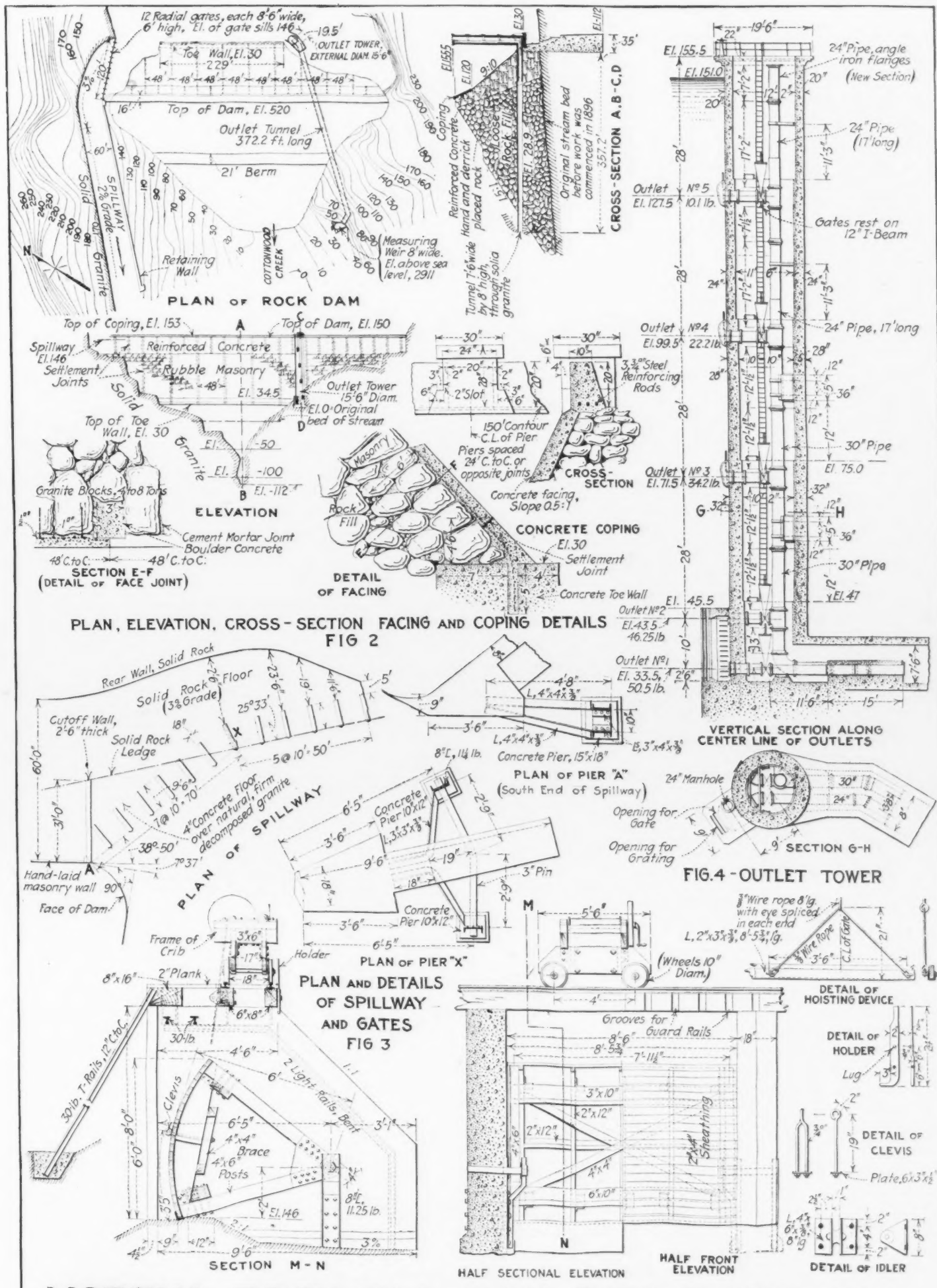
In the vicinity of San Diego storage capacity must be provided sufficient to supply water for from 5 to 7 successive dry years. The company already named derives its supply from storage works on Otay Creek and the Cottonwood River, with tributary drainage areas of "350 sq. miles of clean mountain watershed covered with wild brush."

The Cottonwood drainage area alone has an area of 250 sq. miles, ranging in altitude from 1500 to 6000 ft. and averaging about 3600. Rainfall records were not begun in this drainage area until 1906. At the Barrett dam-site (Elev. 1700) the rainfall has ranged from 29.94 in. in 1906 to 11.28 in. in 1910, while at the Morena Dam (Elev. 3300 ft.) the figures for the same years were 34.73 and 13.94 in. The runoff from the 250 miles of drainage area above the Barrett dam-site was 19.5 billion gallons in 1906 and 5.5 in 1910 (only 4.23 in 1908).

On the Sweetwater catchment area, to the north, the

*For detailed descriptions of the works of this company see "The Five Dams and Wood Stave Conduit of the Southern California Mountain Water Co.," a long fully illustrated staff article published in our issue of Apr. 7, 1904; also see two illustrated articles by M. M. O'Shaughnessy, published in our columns: One dealing with the Dulzura Conduit, Nov. 26, 1908; the other describing a big blast at the Morena Dam, Dec. 30, 1909.

The company's contract with San Diego (August, 1906) calls for a supply of 7,766,000 gal. of water per day, at 4c. per 1000 gal.



MORENA ROCK-FILL DAM, SAN DIEGO, CAL.

records for the 24 years 1887-8 to 1910-11 showed a rainfall of from 4.86 in. in 1901-2 to 16.19 in. in 1894-5. During four years (1899-00 and 1901-2 to 1903-4, inclusive) there was no runoff here.

At San Diego, the mean precipitation for the period 1850 to 1896 was 9.86 in., ranging from 3.02 in. in 1863 to 27.59 in 1884. On the Cottonwood drainage area, Mr. O'Shaughnessy states, a precipitation from 10 to 20 in. and sometimes 30 to 35 in. higher than at San Diego may be expected.

To fill the reservoir formed by the Morena Dam "to the 150-ft. contour," Mr. O'Shaughnessy states, "will require 47,970 acre-ft., or 2,084,000,000 cu.ft., which would be supplied by an average rainfall of 3.6 in. from the watershed. Under favorable conditions, this depth of runoff would be expected from an annual rainfall of 24 in., and, at times, may be the product of only 15 in. precipitation, depending largely on the distribution of the storms, and the frequency with which they succeed each other."

The four dams of the Southern California Mountain Water Co. already built and the Barrett Dam (projected) have the following characteristics:

Name	Type	Height, ft.	Outlet altitude, ft.	Area flooded, acres	Capacity, billion gal.
Lower Otay	Rock-fill*	150	400	869	13.00
Upper Otay	Arched concrete	77	521	164	1.09
Chollas Heights	Earth and steel plate	34	385	17	0.09
Barrett	Not designed	150	1506	936	15.00
Morena	Rock-fill	265	2912	1370	15.00

We will now proceed to quote from Mr. O'Shaughnessy's paper, as follows:

The Morena Dam is 10 miles east of the Barrett Dam site, and on one of the streams which unite just above Barrett at an altitude of 3100 ft. above sea level. It is 35 miles in an air line southeast from San Diego, and about 7 miles north of the Mexican boundary line. The dam is a rock-fill structure [see Figs. 1, 5, 6 and 7 for views and Figs. 2 to 4 for details] facing a narrow cañon and lying between massive granite cliffs which tower 100 ft. high on the brink of a precipitous fall or cataract where the Cottonwood stream takes a plunge of 1000 ft. within a distance of two miles. This dam forms one of a series of five to be constructed by the company.

The Morena cañon is filled throughout with enormous boulders, and, at the site of the dam, a narrow fissure eroded by the stream was found to be 112 ft. below the stream bed at that point. A wall of rubble concrete, 36 ft. thick at the bottom and 12 ft. thick 30 ft. above the steam bed, was the first construction work done in 1896, when the project of building this dam was launched.

At that time it was intended to build the water face on a slope of 1¼ to 1 [and "to put on a water-tight face of asphalt-concrete"] and the downstream slope 1½ to 1; the top width was to be 20 ft. It was also intended to pave the water slope of the rock-fill with an asphalt concrete, which was thought to be durable and impervious. Work was suspended in April, 1898, however, after the toe wall, up to the 30-ft. contour, had been completed and about 120,000 cu.yd. of rock fill had been placed, out of a total of 306,000 cu.yd. required to complete the dam to the prescribed cross-section.

On resuming construction, on May 6, 1909, it was decided to change the upper slope, from the top of the completed toe wall up to the 120-ft. contour, to 9 horizontal to 10 vertical, and make it, from the 120-ft. contour to the top of the dam—150 ft.—½ horizontal to 1 vertical. It was decided to alter the character of the work by placing large masonry blocks of roughly dressed granite, from 6 to 10 tons in weight, selected from the rock piles, on the upstream face of the dam, and have them well bedded and set in cement mortar composed of 1 part cement to 2½ parts sand, and behind this masonry skin, about 7 ft. thick, to place all the stone, by hand and derrick, for a width of 50 ft. back from the face, in order to provide consistent support for the skin. [During construction numerous men were employed on the face of the hand and derrick-placed rock "to break off the sharp edges of flat stones, and chink in the cavities with broken rock."]

The top of the dam is 16 ft. wide, and is crowned with a 3-ft. concrete coping to provide for wave wash. The back slope is 1½ horizontal to 1 vertical, with a berm of 21 ft. at the 100-ft. contour to provide for future extensions in raising the dam. This berm was practically created by the alteration of the face slopes, which originally contemplated a flatter water slope.

In the original work, done 12 years ago without proper continuous technical supervision, there was a little recklessness in the disposition of the materials in the dam, and it was necessary, when the work was resumed in 1909, after a thorough examination, to tear out a large part of the old fill behind the toe wall, remove all loam or other objectionable material, and rebuild with a clean, well placed rock-fill.

At one time, after seeing the nature of the old construction, the writer was almost committed to the idea of letting the old mass stand and, as the additional rock was being placed, hydraulicking a granite surface soil from the adjoining hills into the interstices as the dam was being raised. After a thorough discussion of the matter, however, with many brother engineers, and especially with George L. Dillman, M. Am. Soc. C. E., who seemed to have a clearer conception than any one interviewed as to the requirements of a rock-fill dam*, the present method of procedure was decided on: that is, to construct a water-tight skin for the face of the dam and keep the rock fill absolutely clear of any soil or silt, and thus provide free drainage for any possible leaks which might occur in the future, without impairing the integrity of the mass by washing out sand or other solvent materials.

To obviate further any serious cracking of the skin which might be caused by settlement, grooves, 3 ft. square, and 48 ft. c. to c., were placed in the masonry, and into these concrete has been poured and brought to an absolutely smooth surface, the general average plane of which projects 3 in. beyond the general face of the masonry.

In the future it is proposed to place reinforced-concrete slabs, averaging 1 ft. in thickness, on the face of the masonry and attached to it by ¾-in. iron rods, 4 ft. c. to c. These slabs will be joined with ¾-in. water-tight settlement joints, poured with a sand asphalt along the center line of, and resting on, the concrete grooves previously mentioned. A slot 1 ft. wide and 5 ft. deep was left in the old toe wall [see detail, in Fig. 2] into which the reinforced-concrete facing has already been nested and constructed up to the 42-ft. contour, or 12 ft. above the old toe wall. The zero of the dam levels, as shown by the drawings, is the surface of the original stream bed before work was begun.

This toe wall had a leakage of 57,800 gal. per day in 1898, after it was built, with a head of water up to the 30-ft. contour. It will be noticed from Table I that the present leakage, under a head of 65 ft., is only 33,604 gal. per day. [With this head, 23 ft. of the masonry without concrete facing was under water pressure. The diminution in leakage with the increase in head is attributed to the compression of mud and silt in front of the old toe wall of rubble concrete, built in 1897-8. Mr. O'Shaughnessy states that "in all the recent German masonry dams a layer of clay and soil is deposited on the water face of the masonry."] This is now measured at a bedrock outcrop in the cañon below the dam and about 1000 ft. from it.

TABLE I—LEAKAGE OF MORENA RESERVOIR [1911]

Date	Depth of water, in feet	Leakage, in gallons per 24 hours.
Jan. 13	42	29,727
March 6	48	97,226
March 11	53	120,596
March 14	55	104,152
April 5	60.37	70,448
April 19	62.3	51,053
April 25	63	46,529
May 1	63.5	51,053
May 12	64.25	46,529
May 14	64.37	51,053
May 22	64.78	37,481
June 5	65.33	33,604

As the freight rates from San Diego to Morena—a distance of about 60 miles by wagon road, with maximum grades of 16% to be overcome—run up to about 1c. per lb., it has been imperative to reduce to a minimum the quantities of materials necessary to make a first-class job, on account of the excessive cost of hauling to the dam site.

The cañon walls at the dam site are all of clean, hard granite, singularly free from fissures and seams, and the width between them is only 80 ft. at the stream bed and 520 ft. at the 150-ft. contour—the level of the top of the present completed dam. It has been necessary to add about 186,000 cu.yd. of rock to the original 120,000 cu.yd., in order to complete the dam to the prescribed cross-section.

* Steel plate diaphragm, 1-in. thick, protected by concrete.

*See Mr. Dillman's discussion of this paper, printed separately directly after this article.—Ed.

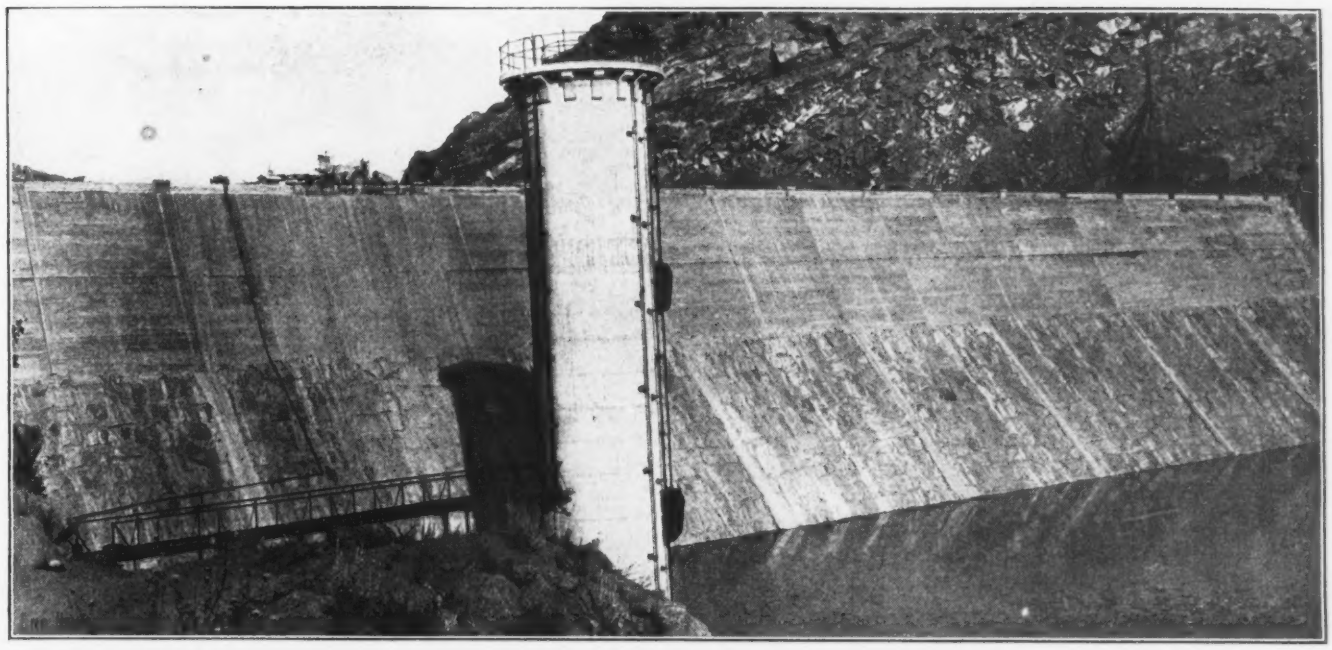


FIG. 5. UPSTREAM FACE, LOOKING WEST

FIG. 6. DOWNSTREAM FACE, SHOWING LOOSE ROCK

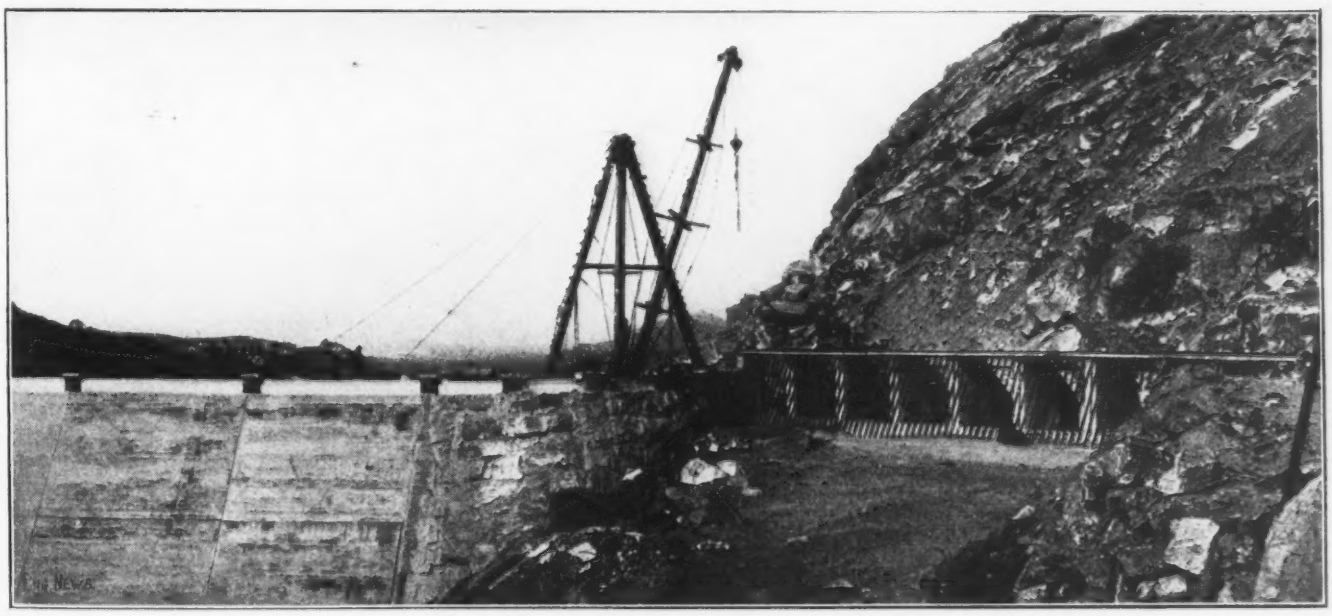


FIG. 7. SPILLWAY AND PART OF DAM, LOOKING DOWNSTREAM

FIGS. 5-7. VIEWS OF MORENA ROCK-FILL DAM, SAN DIEGO COUNTY, CALIF.

Cableways—Construction operations were prosecuted with two Lidgerwood cableways, which were operated from towers about 300 ft. above the stream bed. The fixed cable was 2½ in. in diameter and 1350 ft. long, covering the lower slope of the dam. The other cable was mounted on movable trucks, which had a movement of 170 ft. on tracks at right angles to the axis of the dam, and was able to cover the whole of its water slope; this cable was 2¼ in. in diameter and 1100 ft. long. Each cable was able to handle readily loads up to 10 and 12 tons. All the large rock was chained, and was either picked up by the cable directly or delivered to it by feeding derricks, and transferred by the cable to the fill; the smaller rock was carried in 6x8-ft. skips, each having a capacity of 2 cu.yd. It was possible to move the track trolley cable into a new position in about 2 hours, which made a very convenient arrangement for moving the stone from the quarries directly into the dam work, where it was re-handled by derricks for the face masonry and back-filling.

Signaling Apparatus—In order to control the rapid operation of cables and the exact delivery of rock at certain points of the dam, and to communicate directions to the operating engineers, who were unable to see the work, a new system of signaling was devised. The system of bells used in the old days was abandoned, and an annunciator consisting of a box having ten compartments, each 8x8 in. in size, was placed within view of the engineer. The front of each compartment was closed by a pane of frosted glass and on these the following signals were painted: "HOIST," "LOWER," "GO OUT," "COME IN," "FAST," "SLOW," "STOP," and three spare spaces were left for special signals. At the back of each compartment were mounted two Edison keyless wall sockets with 16-cp., 110-volt lamps. The lamps were wired with a common return wire and an individual wire for the other terminal of each lamp, making 11 wires in all. These wires were of No. 14 copper, covered and cabled, and the outside was protected by jute braid. Each flexible cable was 650 ft. long, and could readily be moved to any favorable position on the south or operating end of the dam. At the signaling end of the cable, ten switches were mounted and normally held open by a spring requiring the pressure of the operator's fingers to close it. The switches were mounted on an insulated base in such a way that the leads were brought into them without coming into contact with the wooden framework. A 1¼-kw., 125-volt, direct-current, compound-wound generator was used, operating at a speed of 1650 r.p.m. The generator was driven by one C. H. Dutton, 5-hp. vertical steam engine, at a speed of 300 r.p.m. The engine was supplied with steam tapped from one of the boilers of the big Lidgerwood engines. By this system, a man, with the switch-signal board, moved around the dam to the most effective points for observing the control and placing of rock as the work progressed, without interfering with guy wires and absolutely preventing accidents, for, in 2½ years of operation, not a man was injured because of any confused signals.

Blasting Rock—In the construction work of 1896 and 1898, large blasts of powder were used indiscriminately in the adjoining hills to break up the solid granite for handling. Powder was used somewhat generously, as at that time the Company obtained it at the very low contract price of 5c. per lb. As the price of Judson powder was raised to 8c. in 1909, and other high-grade powders proportionately, a very careful study of the whole formation surrounding the dam was made before deciding to break rock for the new work. The whole formation in the nearby hills, from which the material for the dam was taken, is a solid granite, and as the cableways were fortunately placed at such a high elevation, 300 ft. above the dam site, a splendid opportunity presented itself for making a mass shot with a large charge of powder without endangering in any way the formation supporting the dam. [See "Eng. News," Dec. 30, 1909, for a full illustrated description of this big blast, written by Mr. O'Shaughnessy. A total of 16.225 tons of powder and dynamite was placed in a tunnel drift and exploded at one shot, loosening 180,000 tons of rock at a total net cost of $7694, or an average of 4.274c. per ton.—Ed.]

The loading of the charge was supervised by J. S. Molony, Resident Engineer, and Messrs. A. H. Crane and H. F. Smith, Agents for the Dupont Powder Co.

On Aug. 30, 1909, the blast was exploded electrically, and the result was most satisfactory, as it displaced about 180,000 tons of rock at the moderate price stated. The greater part of the whole mass of granite was broken into blocks of from 50 lb. to ¼ ton in weight. The fact that about 75% of the pieces weighed less than 10 tons enabled the cables to do very effective work with little plugging.

Spillway—The spillway will have a capacity of 8400 sec.-ft., and will consist of a channel, 60 ft. wide and 5 ft. deep, on a 3% grade, with an inclined entrance 120 ft. wide, all cut out of the granite mountain side. The excavation for the dam was planned so that the materials from the spillway excavation were not wasted, but were put into the structure. The entrance to the spillway will be controlled by twelve radial gates, 8½ ft. wide and 6 ft. high, operated by a crab which runs on a track above the gates [Fig. 3.]

The heaviest floods, measured on the Cottonwood lower down at Barrett, from 250 sq.mi. of water-shed, have been about 7000 sec.-ft., and, as the Morena Reservoir has a capacity of 15,000,000,000 gal., for a water shed of 136 sq.mi., the writer feels secure in the safety of the spillway provisions.]

Outlet Tower—Through the solid bedrock on the south side of the dam at the 30-ft. contour, a tunnel, 387 ft. long, 8 ft. wide, and 7½ ft. high, was drifted, through which the

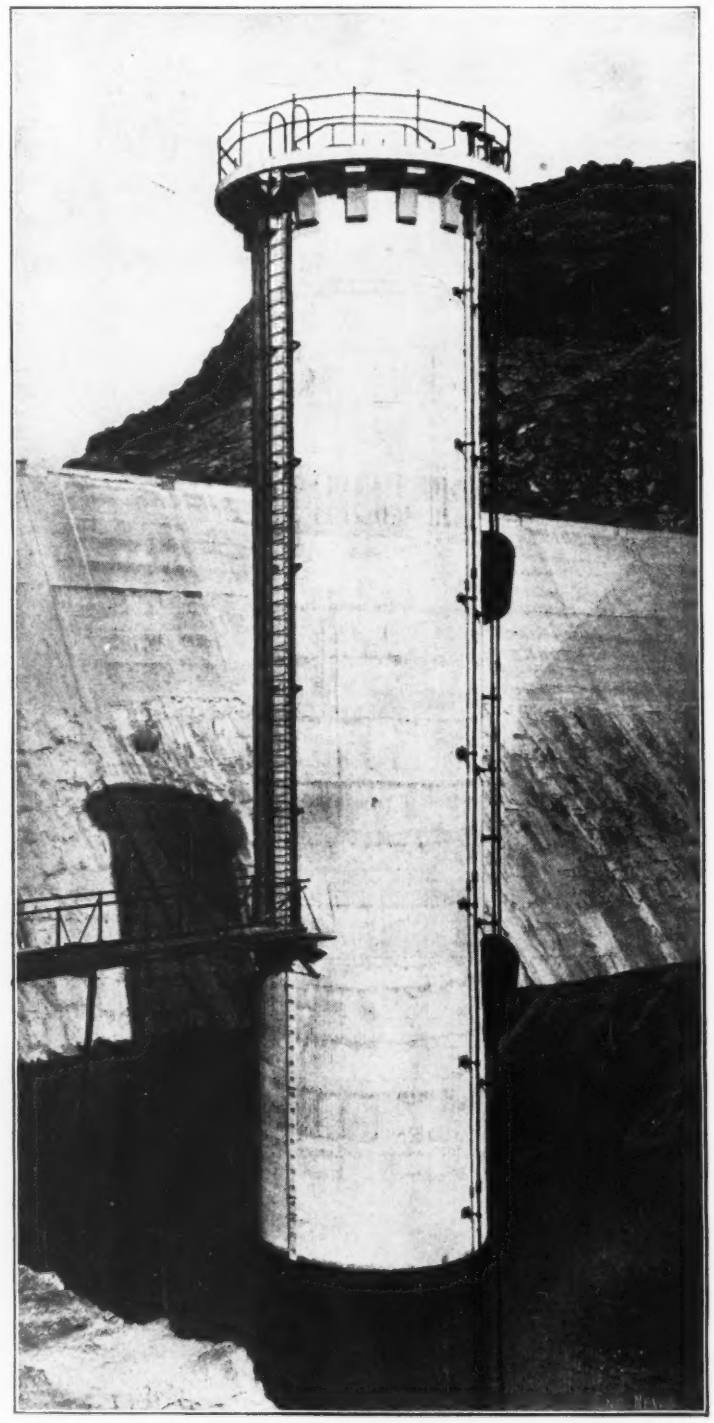


FIG. 8. VIEW OF OUTLET TOWER, MORENA DAM

water from the reservoir is drawn off. This is done through a reinforced concrete tower [Figs. 4 and 8] 15½ ft. in external diameter, with walls varying in thickness from 36 to 20 in. At the top of this tower, at an elevation of 155½ ft., there is an operating deck of reinforced concrete from which the outer gates are regulated. These gates are of the Coffin Valve Co.'s sluice type with vertical stems controlled by guides let into the concrete. Around each gate there is

a screen to keep trash and drift from entering the 24-in. circular cast-iron pipes passing through the walls of the tower and connecting with a 30-in. vertical down-pipe which discharges into the tunnel. These outlets are 28 ft. apart vertically, so that the water may be drawn off under a light head from any of these levels. Between each opening and the down-pipe there is a curved, removable, bolted, flanged casting to enable the gates to be easily removed, if it is ever found necessary. Each is attached to Crane gates which are operated from platforms inside the tower at the different levels, and are used for emergency purposes only.

The admission of water through the outer sluice-valves relieves the leaf-valves from any chattering effect developed by the spouting water which discharges into the down-pipe and flows freely through the tunnel. There is also an independent 24-in. cast-iron pipe which will be used for washing out the sediment which, in the future, may accumulate near the base of the outlet tower. This pipe passes through the foundation of the tower and is connected with the tunnel. The inner 75 ft. of the tunnel—in solid granite—is lined with concrete; it is connected with the base of the tower, and incloses the pipes which discharge at the floor of the tunnel, so that every precaution has been taken to obtain, at a moderate expense, as simple and safe an outlet as possible. From the outer end of the tunnel the water will be permitted to flow at present along the natural grade of Cottonwood Creek until it is picked up above the Barrett Dam site by the Dulzura Conduit.

The work has been done by day's labor under the supervision of J. S. Molony, acting as resident engineer and general superintendent, with R. Wueste and R. P. McIntosh as assistants. About 95 men have been constantly employed since the blast explosion of Aug. 30, 1909, and the work has been peculiarly free from accidents, owing to the careful and conscientious supervision exercised by the men in charge.

The face masonry and back-filling have been expensive, the average cost of the whole work having been $2.50 per cu.yd., but the actual placing of the rock in the dam from the quarries has not cost more than $1 per cu.yd. The whole plant had to be rehabilitated on resuming work in 1909, which, of course, has added slightly to the unit costs, though labor conditions at present in that part of California have made work cost about 30% in excess of prices twelve years ago.

The writer has acted as chief engineer and consulting engineer of the project, and has not been restrained in any way by the president of the company, Mr. Spreckels, who practically owns the entire water system, from modifying the plan of operations or type of construction to suit conditions as the work progressed.

[The writer believes a reading of the paper and discussion will have developed the following conclusions:

(1) That a masonry dam, with a wagon-hauling cost of 1c. per lb., or $4 per bbl. for cement, would have been more expensive than the present structure.

(2) That freedom from uplift pressure is a desirable feature in favor of the rock fill type.

(3) That the great "Hydraulic Principle" of one impervious surface next to the water pressure, as elucidated by Mr. Dillman, is the object to be obtained by engineers in dam construction.

(4) That rock can be excavated economically by mass shots at higher levels above a dam without endangering the site formation, provided the strata are located so that the effects of the explosion will not open seams in the vicinity.

(5) That the circular outlet tower of the type designed is the most economical that can be constructed.]

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The Great Hydraulic Principle: Or How to Make Engineering Structures Hold Water*

By George L. Dillman†

As Mr. O'Shaughnessy has given the writer some credit in the paper,‡ it may not be amiss to enlarge on the great "Hydraulic Principle." This principle applies to practically all hydraulic construction. It has been persistently ignored by many alleged experts, always to the detriment, and often to the destruction, of the works. Where intelligently applied, the result has been safety and economy. Just why it has not been announced by the great writers on hydraulics and taught as a fundamental principle in engineering schools has never been apparent to the writer.

Briefly stated, the principle is this: Construct one impervious surface, and build the rest of the structure to support that surface. If this surface should not be watertight, make it as nearly so as possible, in order that seepage or leakage will not be allowed to accumulate pressure against some other surface, or do other damage in getting away.

In the case of masonry or concrete dams, the particular part to make tight is the upstream face. If this is tight and supported, the result will be a dam; otherwise, a failure. This support is: (1) solid masonry or concrete, the result being the so called uniform-sectioned type; or, (2) buttresses of masonry or concrete, resulting in the multiple-arch dam—safer and more economical; or (3) a mass of loose rock, as in the present case, resulting in a stable structure.

In (1), special care must be taken that the upstream face is the least pervious surface, because, making any other surface tighter would tend toward weakness. Carried to the limit, making the downstream surface of ordinary types the most nearly watertight would insure failure. In (2), the multiple-arch or buttressed-wall type, no special care need be taken. Seepage will find its way out through the arches. In (3), or the present case, the loose rock fill takes care of the seepage if only ordinary care is taken in clearing the foundation for it.

The particular method of supporting the impervious (or most nearly impervious) surface is generally a matter of dollars and cents. That the author [in the case of the Morena rock-fill dam, with its impervious upstream face.—Ed.] has chosen the best one must be conceded, when the price of cement is considered. In other words, the loose rock wall undoubtedly costs less than any other support. To have placed any fine material in the loose rock would have been a mistake, not necessarily fatal, but an added expense, possibly resulting in failure. It costs money, does no good, and may be harmful; yet it has been done recently in California.

In the case of earth dams, with special cores of puddled clay, masonry or steel, earth on the upstream face acts in one of two ways. It may be impervious, making the core unnecessary, or it may be merely a support to the impervious core. This earth generally needs riprapping or paving, in order to resist wave action. In the case of puddle, it is necessary to prevent the puddle from drying out. In the case of masonry or steel, it seems to be unnecessary, as masonry or concrete could be built on a batter which would obviate the need for support. As steel is not a permanent construction material, its life would depend on its coating, which itself might require some protection; but the downstream material should be pervious. All possible seepage through the core should get away without eroding the material or producing pressure.

In the case of timber dams, the structure that stands is a face of planking connected with sheet-piling, as tight as the builder can make, supported by cribs, bents, loose rock, or something else, but always following the "Hydraulic Principle." Tightening it in more than one place is expensive and often fatal.

Other structures may well be mentioned here. A retaining wall should always have drains through it to prevent it from becoming a hydraulic structure. A steel tank or steel pipe should always be calked on the inside, as the outside calking only forms a small lip for tightness and soon rusts off or is forced open, whereas the inside calking has the necessary support. In a reinforced-concrete reservoir, the concrete forms the impervious surface, the steel its support. The location of the reinforcement and its initial tension are matters of moment. If the reinforcement is put in without initial tension, the concrete must give before the strength of the reinforcement is developed—this is the most common cause of leaky structures. Other cases of application cannot fail to occur to readers. The application of the principle cannot help but be efficient and economical.

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Turkey Buzzards as Scavengers have long been looked upon, like the gulls of our northern seaports, as valuable aids in the sanitation of tropical and subtropical cities. It now appears from a news dispatch in the New Orleans "Picayune" that they are falling into disrepute. The Louisiana State Live Stock Sanitary Board has begun a war on the turkey buzzard and induced the State Conservation Commission to declare the buzzard a transmitter of disease, and to order its extermination. The attorney general of the state has given his opinion that the law does not protect the buzzard, since it has become destructive of public and private property.

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*From a written discussion of a paper by M. M. O'Shaughnessy, on the "Construction of the Morena Rock-Fill Dam, San Diego County, Calif." The paper begins on p. 27 and this discussion appears on pp. 51 and 52 of the "Transactions" of the American Society of Civil Engineers, Vol. LXXV (1912).

†Nevada National Bank Building, San Francisco, Calif.

‡See foregoing acknowledgement.

Concrete Foundation for Tracks at Street Crossings

At the recent annual meeting of the American Railway Engineering Association there was some discussion as to the construction of tracks across paved streets, more particularly with regard to the foundation. Mr. Campbell, Engineer of Maintenance-of-Way of the El Paso & Southwestern Ry. System, referred to the use of a concrete foundation as used at El Paso, Tex., and which is specified by city ordinance. In the discussion he stated that the city requires this concrete construction and that the railway has found it very desirable, if not absolutely necessary, to have such a foundation in order to keep the track in surface, so that it will not require frequent attention. We have since received from Mr. Campbell a drawing of this construction, which is shown in the accompanying cuts.

It will be seen from Fig. 1 that a bed of concrete, 10 ft. wide and 12 in. deep under the ties, extends the full length between property lines at the street crossing. The concrete is also filled between and over the ties, to form

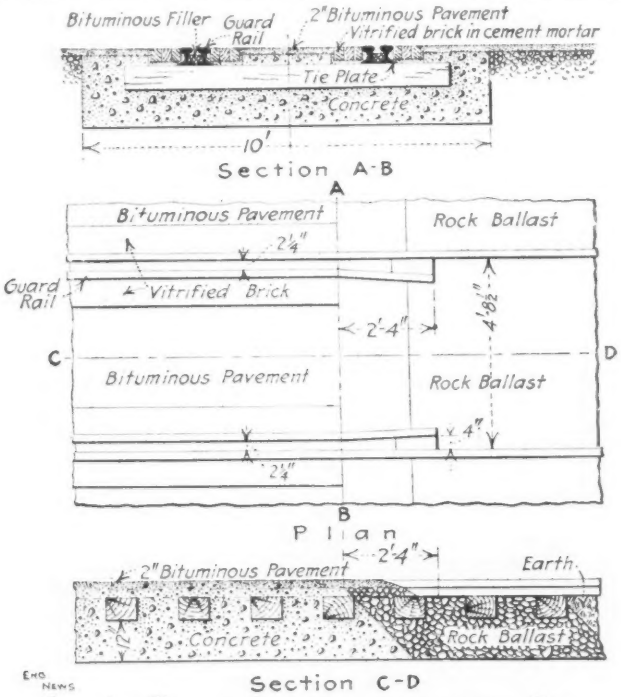

FIG. 1. TRACK CONSTRUCTION WITH CONCRETE FOUNDATION AT STREET CROSSINGS; EL PASO, TEX. (EL PASO & SOUTHWESTERN RY.)

the base for a 2-in. bituminous pavement. Beyond the ends of this concrete bed there is stone ballast beneath and between the ties. Parallel with each track rail is a guard rail of the same size, having its inner flange cut off so that the rail can be placed to leave a 2¼-in. flangeway. At the ends (beyond the property lines) this guard rail flares out for 2 ft. 4 in. to an end spacing of 4 in., where there is placed a filler block. The two rails rest on flat steel tie-plates ½x8 in., 13 in. long, having one spike hole on the outside of each rail and two spike holes between the rails. Between the rails is a bituminous filler, the top of which is 2 in. below the top of the rail. The filling is not shaped to fill the space under the rail heads, although in many cases this is considered desirable, in order to prevent the calks of horseshoes from getting caught under the rail heads.

In regard to the paving, it will be seen that while a 2-in. bituminous paving is used between and outside the rails, a triple row of paving bricks is laid adjacent to each rail. The bricks are bedded in cement mortar, which partly fills the joints, while the upper part of the joint is filled with a bituminous composition. This is shown in the section, Fig. 2. The use of the brick was found to be necessary, as the bituminous pavement would not stand up against the vibration of the rails. The paving between the rails is laid ⅜-in. below the rail heads.

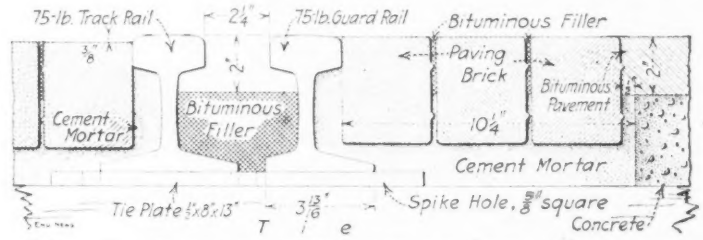

FIG. 2. DETAILS OF PAVING OF STEAM-RAILWAY TRACK AT STREET INTERSECTIONS

The concrete base is used for the reason that it has not been found practicable to maintain proper line and surface on track carried across the streets on stone ballast. The construction is not found to be too rigid, and is the most satisfactory arrangement that has been tried on this road.

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The Mechanical Properties of Wood grown in the United States are given in tabular form in Circular 213 of the U. S. Forest Service, issued Mar. 24, 1913, and available at 5c. per copy, by application to the Superintendent of Documents, Government Printing Office, Washington, D. C. The table gives the results of tests on 49 species of American wood, tested in green condition in the form of small clear pieces. The number of test pieces from each tree varied from 40 to 120, and the total number of tests represented in the table is about 25,000. The test material was cut from typical trees, selected by members of the Forest Service and records were made of the conditions of growth. The table gives the kind of tree, the locality where it was grown, the number of trees from which the pieces were taken, description of the nature of the wood, and results of bending tests, both static and impact, compression parallel and compression perpendicular to the grain, hardness, shear parallel to the grain, cleavage or splitting, and tension at right angles to the grain.

Overflow from an Inverted Sewer Siphon, at Ames, Iowa, combined with bottom land being flooded at times with the overflow of a storm sewer, gave rise, some weeks ago, to the story that suits had been brought on account of nuisance from the local sewage-treatment works. Through the kind services of Prof. A. Marston, of Iowa State College, we have received the following statement from J. Q. Wickham, city engineer of Ames:

It is true that there have been some suits filed against the City of Ames, objecting to trouble arising in part from the overflow of the 8-in. inverted siphon of Sewer District No. 1, but largely from the storm water overflowing the bottom land near the plant at the same time.

The 8-in. siphon has now considerable growth on the inside, thus reducing its capacity to such a extent that in the spring, when the sewers take some ground water, it cannot carry all the sewage of the district, and, therefore, at such times overflows and causes some trouble at the foot of the hill on Duff Ave.

The original plan of the 8-in. siphon was so arranged that when the rate of flow had reached a certain amount it was to be supplemented by a 12-in. cast-iron pipe. The city authorities have been warned in my yearly reports of the past three years that the time was now at hand when something should be done, but, owing to a lack of funds, they have not been able to comply with the requirements, until recently. I will say, however, that before the pending suits had been filed steps had been taken by the sewer committee of Ames to enlarge the inverted siphon and also to take care of the storm water as well, and there was not the shadow of a reason for any suits. Material has already been ordered for the siphon, and the plans for stom-water sewer to extend to Squaw Creek, one-half mile south of the sewage-disposal plant, are now completed.

I would like to have it distinctly understood that the suits were not brought on account of the operation of the plant itself, as no cause for such complaint can be shown, as the plant has been working perfectly, even though it has been required to carry more than 100% overload through its filters.

General Method for Drawing Influence Lines for Stress in Simple Trusses

By Malverd A. Howe*

[Copyright, 1913, by M. A. Howe.]

An influence line for the bending moments at the center of moments for any member of a truss on two supports for vertical loads can be constructed by a method which is perfectly general in its application. The truss may be of any shape, and the loads may be applied to either the upper- or lower-chord joints.

A section is passed through the truss, in usual manner, cutting the member whose influence line is to be drawn. This section must evidently also cut a stringer in the panel containing the cut loaded chord. Let:

d = the horizontal projection of the length of the stringer which is cut by the section. This stringer will be called the *cut stringer*.

b = the horizontal distance from the left support of the truss to the left end of the cut stringer.

s = the horizontal distance from the left support of the truss to the center of moments.

h = the vertical distance, at the left end of the cut stringer, between the two chord members which are cut by the section.

h' = the vertical distance between the same chords at the *right* end of the cut stringer.

General Rule

To draw the influence line, proceed as follows:

(I) Through any point A (refer to Fig. 1; all other figures are lettered correspondingly) in a vertical line passing through the center of moments, draw a horizontal line cutting the vertical line through the left support of the truss at C and the vertical line through the right support at B.

(II) From C, at *any convenient scale*, lay off vertically downward the distance $CD = AC = s$, and connect D and B by a right line.

(III) Through A and D draw a right line and prolong it until it cuts the vertical line drawn through the left end of the cut stringer at E.

(IV) Draw a vertical line through the right end of the cut stringer, intersecting the line CB at F, and connect E and F by a right line.

(V) The polygon $DEFBD$ contains the influence line sought; the ordinates between line $DEFB$ and line DB are the respective moments for unit loads on the truss vertically above them, i.e., the lines $ef = z_1$, $rc = z_2$, $gk = z_3$, are proportional to the stresses produced by loads of 1 lb, at W_1, W_2, W_3, respectively. The ordinates are measured at the scale used in laying off the distance $CD = s$.

Although the method outlined here applies to any of the figures accompanying this article, yet for greater clearness several forms of the trusses shown will be considered in detail.

Trusses with Simple Paneling

Web Members in Simple Trusses *having one or both Chords Inclined*—Figs. 1a and 2 show trusses having one set of web members vertical, and Fig. 1*b* a truss where both sets are inclined. In Figs. 1*a* and 2 the construction of the influence line $DEFB$ is identical.

To prove the construction correct, let the angles made with AB by the lines AE, EF and DB be respectively O_1, O_2 and O_3, and let the distance from the left support of the truss to the unit load be, in general, represented by a. While the load W_1 is to the left of the cut stringer, or to the left of the vertical through E, the moment is:

$$M_s = \frac{W_1\,(l-a)}{l}\,s - W_1\,(s+a) = W_1\,(l-a)\,\frac{s}{l} - W_1\,(s+a)\,\frac{1}{1}$$

or,

$$M_s = W_1\,(l-a)\,\tan O_3 - W_1\,(s+a)\,\tan O_1 = W_1(pe - fp) = W_1(-ef)$$

If the load, W_2 (or W_2'), is on the cut stringer, or between the vertical lines passing through E and F, the moment is,

$$M_s = \frac{W_2\,(l-a)}{l}\,s - W_2\,\frac{b+d-a}{d}\,(s+b) = W_2\,(l-a)\,\frac{s}{l} - W_2\,(b+d-a)\,\frac{s+b}{d}$$

or,

$$M_s = W_2(l-a)\,\tan O_3 - W_2\,(b+d-a)\,\tan O_2 = W_2(qr - cq)$$

$= W_2(-cr)$ when the load is to the left of the vertical through G,

$= W_2(+cr)$ when the load is to the right of the vertical through G.

When the load is beyond the cut stringer, or on the right of the vertical through F, the moment is

$$M_s = \frac{W_3\,(l-a)}{l}\,s = W_3\,(l-a)\,\frac{s}{l}$$

$$= W_3\,(l-a)\,\tan O_3 = W_3\,(+gk)$$

Maximum Load-Position—For uniform loads, the influence diagram $DEGFB$ at once indicates the portions of the span which are to be loaded to produce maximum moments (and hence maximum stresses).

The criterion for giving the position of wheel-loads producing the maximum moment is readily found from the influence diagram. For cases which usually occur in practice, the portion of the span on the left of the cut stringer may be considered as unloaded. Let z_2, z_2' and z_3, be the ordinates of the influence diagram directly below the wheel-loads W_2, W'_2 and W_3. The moment is,

$$M_s = W_2 z_2 + W'_2 z'_2 + W_3 z_3$$

If the loads move towards the left a distance δx, and no additional load comes on the span from the right and no load moves off the left end of the *cut stringer*, the moment becomes,

$$M'_s = -W_2\,(z_2 - \delta x\,\tan O_3 + \delta x\,\tan O_2) + W'_2(z'_2 + \delta x\,\tan O_3 - \delta x\,\tan O_2) + W_3(z_3 + \delta x \tan O_3)$$

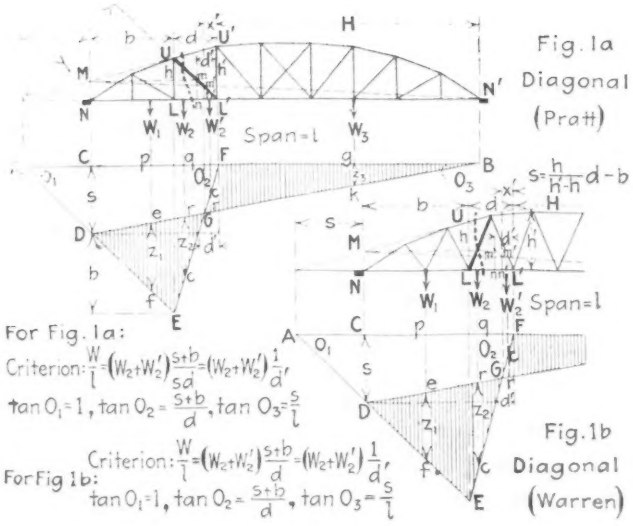
The difference between these moments is:

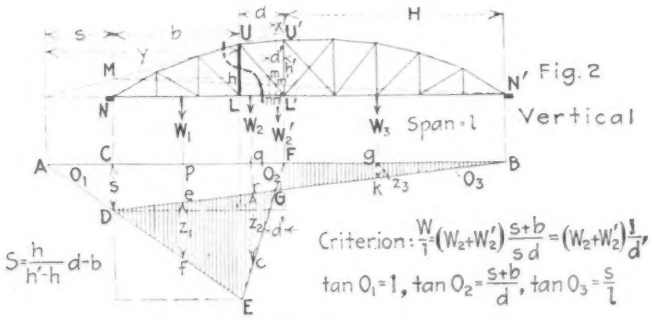
$$M'_s - M_s = \delta M_s = -W_2\delta x\,(-\tan O_3 + \tan O_2) + W'_2\delta x\,(\tan O_3 - \tan O_2) + W_3\delta x\,(\tan O_3)$$

Dividing through by δx and placing $\frac{\delta M_s}{\delta x} = 0$ to find the point of maximum,

$$\frac{\delta M_s}{\delta x} = -W_2\left(-\frac{s}{l} + \frac{s+b}{d}\right) + W'_2\left(\frac{s}{l} - \frac{s+b}{d}\right) + W_3\frac{s}{l} = 0$$

*Director of the Departments of Architecture and Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind.





FIGS. 1 & 2 - WEBS OF CURVED-CHORD TRUSS

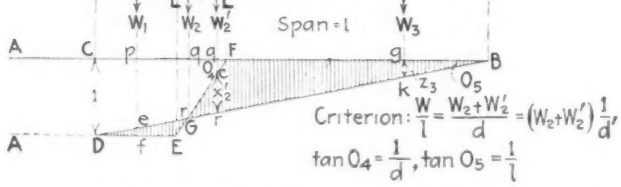


FIG. 3 - WEB OF PARALLEL-CHORD TRUSS (INFLUENCE DIAGRAM FOR SHEAR)

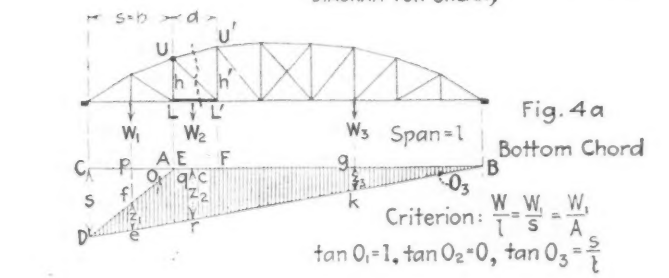


FIG. 4 - CHORDS OF CURVED-CHORD TRUSS

INFLUENCE LINES FOR WEBS OF TRUSSES WITH SIMPLE PANELS

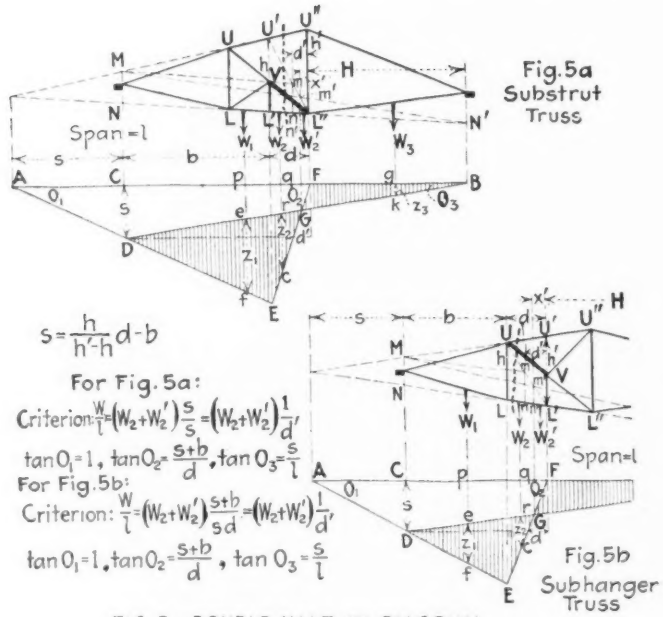


FIG. 5 - DOUBLE HALF OF DIAGONAL

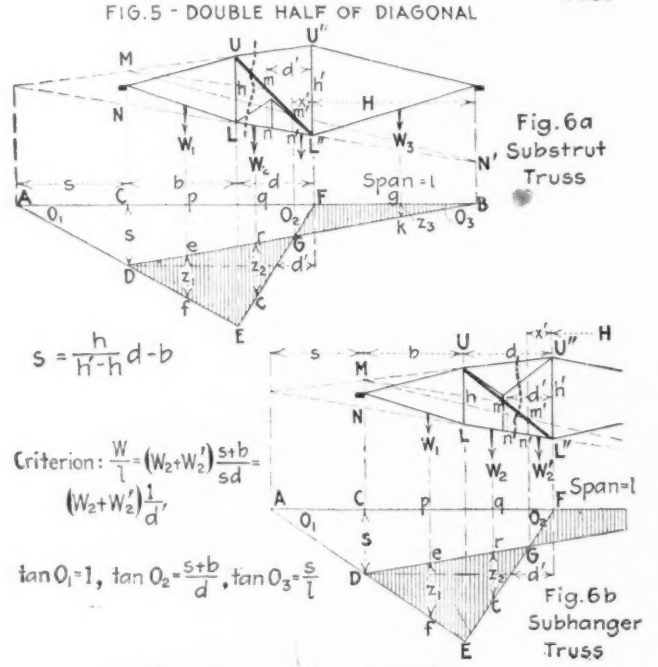


FIG. 6 - SINGLE HALF OF DIAGONAL

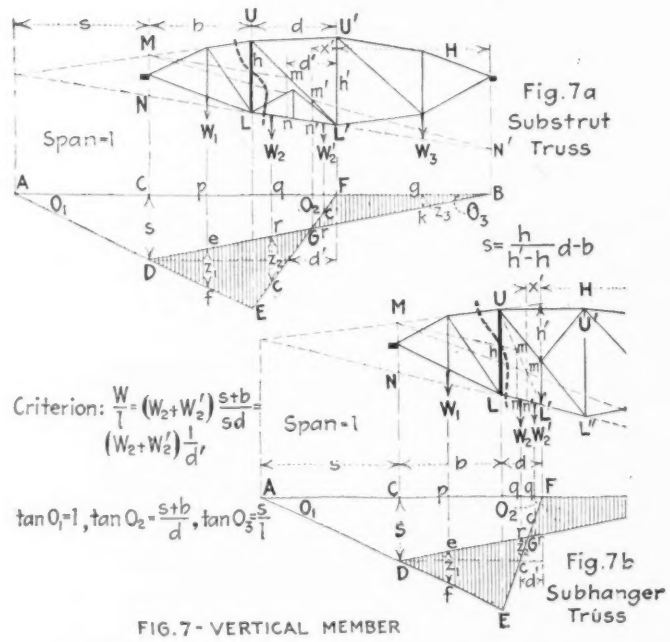


FIG. 7 - VERTICAL MEMBER

INFLUENCE LINES FOR WEBS OF TRUSSES WITH SUBDIVIDED PANELS

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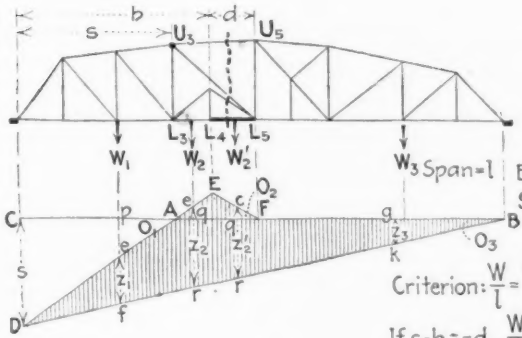

Fig. 8 Bottom Chord, Substrut Truss

Criterion: $\frac{W}{l} = \frac{W_1+W_2}{s} + W_2' \frac{s-b}{sd}$

If $s-b=-d$, $\frac{W}{l} = \frac{W_1+W_2-W_2'}{s}$

$\tan O_1 = 1$, $\tan O_2 = \frac{s-b}{d}$, $\tan O_3 = \frac{s}{l}$

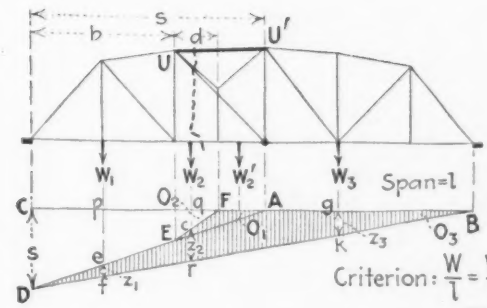

Fig. 9 Top Chord Subhanger Truss

Criterion: $\frac{W}{l} = \frac{W_1}{s} + W_2 \frac{s-b}{sd}$

If $s-b=-2d$, $\frac{W}{l} = \frac{W_1+2W_2}{s}$

$\tan O_1 = 1$, $\tan O_2 = \frac{s-b}{d}$, $\tan O_3 = \frac{s}{l}$

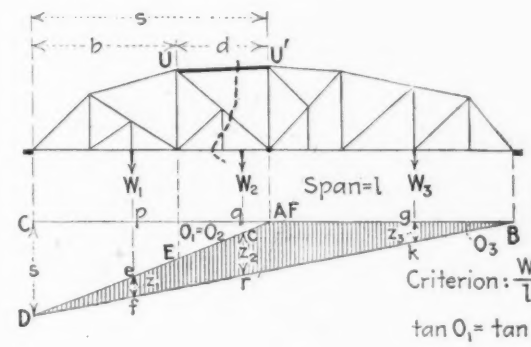

Fig. 10 Top Chord Substrut Truss

Criterion: $\frac{W}{l} = (W_1+W_2)\frac{1}{s}$

$\tan O_1 = \tan O_2 = 1$, $\tan O_3 = \frac{s}{l}$

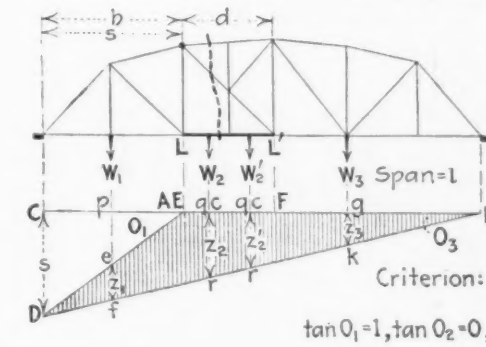

Fig. 11 Bottom Chord Subhanger Truss

Criterion: $\frac{W}{l} = \frac{W_1}{s}$

$\tan O_1 = 1$, $\tan O_2 = 0$, $\tan O_3 = \frac{s}{l}$

CHORDS OF TRUSSES WITH SUBDIVIDED PANELS

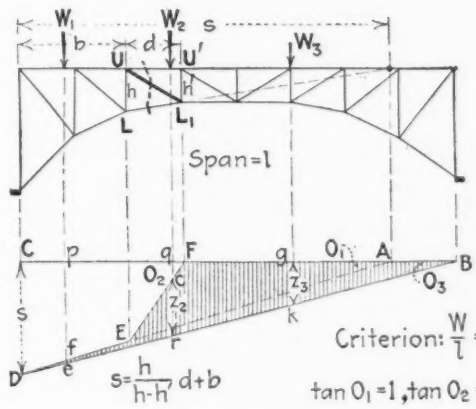

Fig. 12 Diagonal Member

Criterion: $\frac{W}{l} = \frac{W_1}{s} + W_2 \frac{s-b}{s}$

$\tan O_1 = 1$, $\tan O_2 = \frac{s-b}{d}$, $\tan O_3 = \frac{s}{l}$

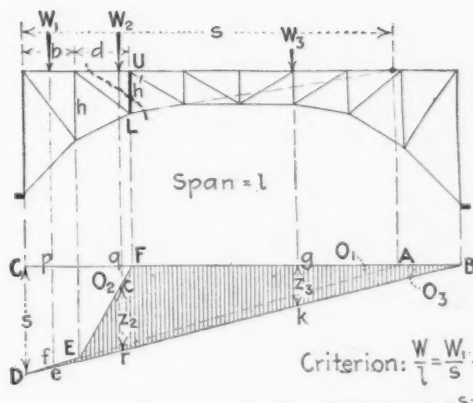

Fig. 13 Vertical Member

Criterion: $\frac{W}{l} = \frac{W_1}{s} + W_2 \frac{s-b}{sd}$

$\tan O_1 = 1$, $\tan O_2 = \frac{s-b}{d}$, $\tan O_3 = \frac{s}{l}$

WEBS OF TRUSSES WHERE CENTER OF MOMENT LIES BETWEEN SUPPORTS

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hence, if $W = W_2 + W'_2 + W_3$, the total load on the span,

$$\frac{W}{l} = (W_2 + W'_2)\frac{s+b}{sd} = \frac{W_2 + W'_2}{d'}$$

Where

$$\frac{1}{d'} = \frac{s+b}{sd} \text{ or } d' = \frac{d}{s+b}s = \frac{s}{\tan O_2}$$

The value of d' is found graphically from the influence diagram by drawing a line through D parallel to CB until it cuts the line EF, then d' is the distance indicated in the figures. This value may also be found graphically without drawing the influence line by simply drawing in the truss diagram the line Mm parallel to the cut bottom chord LL' and prolonging it until it cuts a diagonal line drawn from the intersection of the cut top chord and a vertical through the left end of the cut stringer to the intersection of the cut bottom chord and the vertical through the right end of the cut stringer. This point is indicated by the letter m in the figures. The horizontal distance of this point m from the vertical through the right end of the cut stringer is the value of d'. This is easily shown as follows: From Figs. 1, 2 and 3,

$$mn : h :: d' : d, \text{ or } d' = \frac{d}{h}mn = \frac{s}{MN}$$

$$MN : s :: h : s+b, \text{ or } MN = \frac{s}{s+b}h$$

Therefore,

$$d' = \frac{s}{s+b}d = \frac{d}{s+b}s$$

the value given above.

NEUTRAL POINT—The position of a load which produces no stress in the web member is indicated by the point G in the influence diagrams; for, a load in the truss immediately above G produces no stress in the web member since the ordinate of the influence diagram is zero. The point m' shown in the truss diagram is immediately above G. This point is located by the intersection of

the line MN' and the diagonal drawn as explained in determining d'. Let x' be the horizontal distance from m' to the vertical through the right end of the cut stringer, and $H + x'$ the horiontal distance of m' from the vertical through the right support of the truss. Then, in Figs. 1 and 2,

$$m'q' : h :: x' : d, \text{ or } m'n' = \frac{h}{d}x' = MN(H + x')\frac{1}{l}$$

$$MN : s :: h : s + h, \text{ or } MN = \frac{s}{s+h}h$$

hence

$$m'n' = \frac{H + x'}{l} \times \frac{s}{s+h}h = \frac{h}{d}x';$$

or

$$(H + x')\frac{s}{l} = \frac{s+h}{d}x'$$

which becomes

$$(H + x')\ tan\ O_3 = x'\ tan\ O_2.$$

The ordinate above the point G in the influence diagram satisfies this equality, and therefore G and m' are in the same vertical line.

Web Members in Simple Trusses *Having Parallel Chords*—The case shown in Fig. 3 presents an apparent exception to the general rule for drawing the influence line $DEFB$. The center of moments for any web member is at infinity. Taking N as the reference point, $s = \infty$. For a load on the left of the vertical through E, the moment is

$$M_s = W_1\frac{l-a}{l}s - W_1(s+a) = W_1\frac{l-a}{l}\infty - W_1(\infty + a)$$

Dividing both members of this equation by ∞

$$\frac{M_s}{\infty} = W\frac{l-a}{l} - W_1\left(1 - \frac{a}{\infty}\right) = W_1\frac{l-a}{l} - W_1$$

But $W_1\frac{l-a}{l} - W_1$ is the expression for vertical shear on the right of the load, and, consequently, practically at the load.

If CD is laid off equal to $s \div \infty = 1$, the ordinates of the influence diagram represent vertical shears instead of moments. DE drawn through A which is an infinite distance from the left support, will be sensibly parallel to ACB. It appears that the shear influence diagram is constructed in precisely the manner outlined for the moment influence diagram when CD is made equal to unity. For a load on the left of the vertical through E, the vertical shear is

$$S = W_1\frac{l-a}{l} - W_1 = W_1(l-a)\frac{1}{l} - W_1(1)$$

or,

$$S = W_1(l-a)\ tan\ O_5 - W_1(1) = W_1(pe - pf) = W_1(-ef)$$

In a similar manner it is shown that the ordinates immediately below W_2, W'_2 and W_3, represent the vertical shears produced by unit loads at these points.

The criterion for maximum shear is identical with that given above for maximum moments. Without writing out all the equations, it is evident from Fig. 4 that

$$\frac{\delta S}{\delta x} = -W_2(-tan\ O_5 + tan\ O_4) + W'_2(-tan\ O_4 + tan\ O_5) + W_3 tan\ O_5 = 0;$$

or,

$$-W_2\left(-\frac{1}{l} + \frac{1}{d}\right) + W'_2\left(-\frac{1}{d} + \frac{1}{l}\right) + W_3\frac{1}{l} = 0$$

Therefore,

$$\frac{W}{l} = (W_2 + W'_2)\frac{1}{d} = (W_2 + W'_2)\frac{1}{d'}$$

The points m and m' and the value of $d' = d$ are found in the manner explained for Figs. 1, 2 and 3.

Chord Members in Simple Trusses—Fig. 4 shows the manner in which the influence diagrams for chord-stress moments are drawn, according to the general directions.

The criterion for wheel-loads for trusses having one set of web members vertical is found as follows, referring to Fig. 4a:

$$M_s - M'_s = \delta M_s = W_1\delta x\ (tan\ O_3 - tan\ O_1) + W_2\delta x(tan\ O_3) + W_3\delta x(tan\ O_3)$$

or,

$$\frac{\delta M_s}{\delta x} = W_1\left(\frac{s}{l} - \frac{s}{s}\right) + W_2\frac{s}{l} + W_3\frac{s}{l} = 0$$

Therefore,

$$\frac{W}{l} = \frac{W_1}{s}$$

In Fig. 4b,

$$\frac{W}{l} = \frac{W_1 + W_2}{s}$$

In both cases the criterion is the same; that is, the average load on the span equals the average load on the left of the center of moments.

If both sets of web members are inclined, as shown in Fig. 4c, the construction of the influence diagram remains unchanged as to method, but the resulting diagram is different in form from those shown in Figs. 4a and 4b, and the criterion for maximum moments produced by wheel-loads is different. From Fig. 4c,

$$\frac{\delta M_s}{\delta x} = W_1(-tan\ O_1 + tan\ O_3) + W_2(-tan\ O_2 + tan\ O_3) + W_3\ tan\ O_3 = 0.$$

or,

$$W_1\left(-\frac{s}{s} + \frac{s}{l}\right) + W_2\left(-\frac{s-b}{d} + \frac{s}{l}\right) + W_3\frac{s}{l} = 0$$

Hence

$$\frac{W}{l} = \frac{W_1}{s} + W_2\frac{s-b}{sd}$$

When

$$s - b = \tfrac{1}{2}d, \frac{W}{l} = \frac{W_1 + \frac{1}{2}W_2}{s}$$

Trusses with Subdivided Panels

Web Members—The usual type of truss with subdivided panels has one set of web members vertical. The trusses here considered in detail have inclined chords.

Fig. 5a shows the moment influence diagram for the lower half of the diagonal UL'', in a truss with sub-struts. Since the portion VL'' is a member of the main truss and of the auxiliary truss LVL'', the length of the cut stringer is the horizontal projection of the distance LL''. All of the demonstrations given for Fig. 1 apply to this case. For a truss whose panel subdivision employs sub-hangers

the construction is similar, for the *upper* half of the diagonal; see Fig. 5b.

Fig. 6a shows the influence diagram for the upper portion of the diagonal UL'. This is a member of the principal truss only and hence the horizontal projection of LL' is the length of the cut stringer. The construction of the influence diagram and the demonstrations remain unchanged. In the sub-hanger truss, the *lower* half of the diagonal is subject to the same considerations and construction, as in Fig. 6b.

Fig. 7a considers the vertical UL. This member is in no way influenced by the auxiliary truss, which may be considered merely as a trussed stringer, and therefore the cut stringer is the same as in Fig. 6a. It follows that all constructions and demonstrations remain unchanged. In the sub-hanger truss the same post is subject to the influence of the auxiliary truss, and the length of the subpanel determines the length of the cut stringer as in Fig. 7b.

If the chords are parallel, the diagrams shown in Figs. 5 to 7 will take the form shown in Fig. 3, where CD is unity and the ordinates represent the vertical shear.

CHORD MEMBERS—The two cases shown in Figs. 8 and 9, and 10 and 11, are sufficient to indicate the application of the general method.

In Fig. 8 the bottom-chord member L_4L_5 forms a portion of the main truss and of the auxiliary truss. The length of cut stringer is L_4L_5, and the influence line is drawn according to the general method. The same reasoning applies to the top chord in Fig. 9.

The diagrams for the unsubdivided chord are shown in Figs. 10 and 11 for lower and upper auxiliary truss respectively. They require no further explanation.

WEB MEMBERS IN SIMPLE TRUSSES WHERE THE CENTER OF MOMENTS IS BETWEEN THE SUPPORTS

The trusses shown in Figs. 12 and 13 have inclined bottom-chord members approaching the top chord at the center of the span. This makes the center of moments for some of the web members fall between the supports, as shown. The influence diagrams follow the general law, and indicate that the trusses are to be loaded from end to end for maximum moments. The criterions for wheel-loads are the same as found for Fig. 9. The influence diagrams for the chord members will be of the form shown in Fig. 4a.

A little study of the above explanations shows that, after the center of moments has been located and the length of the cut stringer determined, the construction of the moment or shear influence diagram is a mechanical process following general rules. When the diagram has been constructed as directed, the moments or shears for unit load on any point can at once be scaled, using the scale used in laying off the distance CD. No special calculations are required as is usually stated in textbooks which consider this form of diagram. This particular form of influence diagram forms a part of the influence diagrams for cantilever trusses and two- and three-hinged arches, making the construction of influence diagrams for such structures exceedingly simple.

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An Experimental Roadway is being built in the suburbs of Philadelphia on the direct through road to New York, which carries a heavy automobile traffic. The road is known as the Byberry & Bensalem turnpike. The test roadway is nearly 3½ miles long, and is being laid with 26 different kinds of pavement.

Suggested Code of Ethics of the Oregon Society of Engineers

I. Engineers should be men of sterling honesty and moral integrity. Their success and the standing of the profession depend upon their thoroughness, industry, business talent and upright character. They cannot honorably enter into such competition as that which may exist among business men.

II. They should encourage sound engineering learning, by training in scientific schools, by individual study and reading thereafter, and by actual work.

III. Their clients have a right to expect that the portion of business entrusted to them will receive careful investigation and intelligent treatment. Any information which the engineer has derived from such investigation, and which is peculiar to that business, is to be considered confidential.

IV. In their professional relations, engineers should be governed by strict honor and courtesy. Their conduct toward each other should be such that it will secure mutual confidence and good will.

They should not seek to divert to themselves the work of clients of other engineers.

It is the privilege of a client to transfer his work from one engineer to another; but before the change is made there should be a complete understanding between the engineer in charge and the engineer to whom the work is transferred, to avoid offense.

Communications are to be carried on between responsible heads, and not by unauthorized subordinates.

One engineer should not attempt to secure the services of an assistant or employee of another engineer, without first gaining the permission of such principal.

No assistant or engineer's employee should contract his services to another engineer without first consulting his principal.

An engineer should not hinder the advancement of an assistant, but should give him any aid and encouragement possible.

Criticism of another's work is to be broad and unprejudiced. The whole profession is affected by the success or failure of any member.

The relations between principals and their assistants should be those of frank and mutual helpfulness.

V. Engineers should be willing to assume their proper share of public work, and to render all assistance possible for the general good of the community.

VI. An engineer should not attempt work with which he is unfamiliar or inexperienced. In cases of doubt, consultations should be held with other engineers having broader experiences.

One engineer should not use language that will impair confidence in another engineer.

VII. Fees are to be based on local conditions, and to represent the customary values. One engineer should not seek to undercut others.

VIII. As far as possible, engineers should not be interested in any business that will prejudice their opinions as applied to their work.

They should not receive commissions for materials entering into work of which they have charge.

They should avoid any unprofessional advertising or appearance of commercialism, but should give other engineers the advantage of the record of publication, wherever desirable, of any unusual or interesting feature of their practice.

IX. Their attitude toward contractors should be one of helpfulness and tactfulness, combined with firm and just criticism.

X. An intimate relation should exist between the various branches of engineering.

A committee is to be appointed to try and pass upon a breach of conduct of any of the members. If serious enough, the case then to be handed to the Executive Board, whose decision will be final. Upon a three-fourths vote of the Executive Board, a quorum being present, a member may, after such trial, be expelled from the Society.

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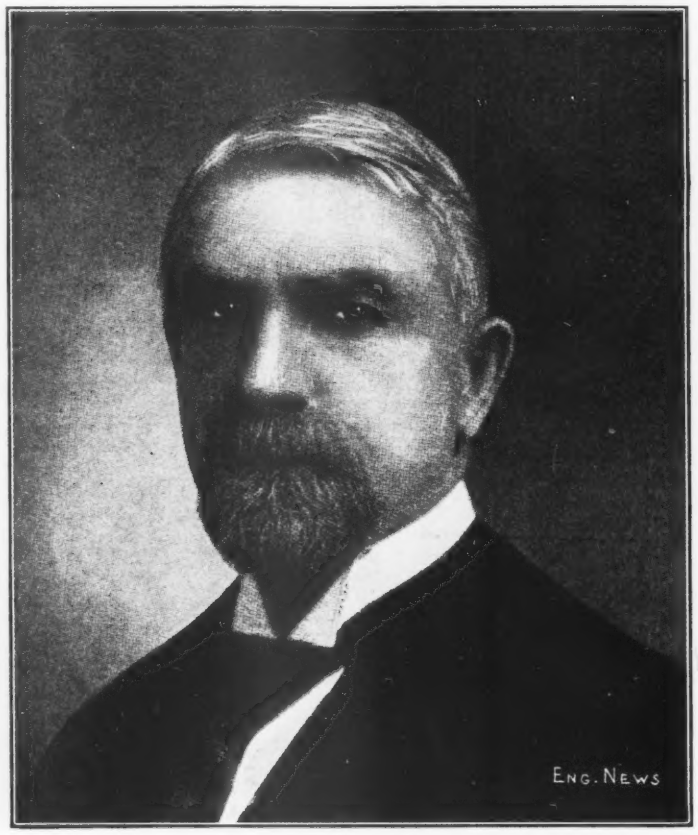
Street Accidents in London, England, cost the lives of 538 persons and injuries to 16,651 more in the year 1912, according to statistics issued by the British Home Office. The greatest number of fatal accidents from any one class of street traffic was 182 deaths caused by motor omnibuses; electric cars caused 37 deaths; motor vehicles, 171; horse-drawn vehicles, 143, and horse-drawn omnibuses, 5. More than half the nonfatal accidents were due to motor omnibuses and other motor vehicles.

Expensive 11-Mile Cutoff To Be Built by the Baltimore & Ohio Railroad*

A 17-mile double-track section of the Baltimore & Ohio R.R. main line in West Virginia is being enlarged to four-track by building a double-track low-grade cutoff 11 miles long, at a cost of about $6,000,000. It extends from Orleans Road to Little Cacapon, W. Va., and goes under the name of Magnolia Cutoff. With its completion the railway will have four tracks and three tracks for the entire 78 miles from Cumberland to Martinsburg, W. Va.

The present two tracks between the termini of the cutoff will be used for westbound traffic, and the cutoff will carry eastbound traffic. Thus the heavier traffic will get the benefit of the low-grade line.

The location of the cutoff is as follows: Beginning at the easterly end, it diverges to the southerly side of the present three-track line beyond Orleans Road, rises on an 0.4% compensated grade 4500 ft. to a crossing of the present tracks, and continues on the same grade through the ridge at Doe Gulley. The present Doe Gully tunnel will be converted into a four-track open cut, with some change in location, and a lowering of the summit level by 10 ft. Thence the new line runs along the hillside above the present tracks to a point east of Hansrote; here it diverges to the left and passes through the ridge just east of Magnolia. It then crosses over the present tracks and over the Potomac River at Magnolia in Maryland, pierces the ridge on the west side of the river and again crosses the river and the present tracks at Kessler's Curve, returning into West Virginia. Then follows hillside location above the existing tracks to a point just west of Paw Paw, where the location again turns to the left and goes through a short tunnel south of the present Paw Paw tunnel. All the old and new lines will be combined in a new four-track line somewhat above the present roadbed, above the highest known stage of the Potomac. At Little Cacapon the existing four-track line is reached.



HORACE GREELEY BURT

The cutoff saves 5.8 miles of distance and 887° curvature in eastbound traffic, and avoids a grade at Hansrote which now requires pusher engines for eastbound trains. It will have four tunnels (the longest about 3000 ft.) and two bridges over the Potomac River.

The construction is to be first-class. Retaining-walls will hold the foot of the slope along the river, and the slopes above the track will be terraced to guard against slides or falling rock. The line will have automatic signals, and at four points interlocking plants (Great Cacapon, Doe Gully, Magnolia and Little Cacapon).

Construction is in charge of F. L. Stuart, Chief Engineer of the Baltimore & Ohio R.R. It will be carried on in eight sections, which have been let as follows: Sections 2, 3 and 4 to H. S. Kerbaugh, Inc., New York; 5 and 7 to Bennett & Talbot, Greensburg, Penn.; 6 and part of 8 to Smith, McCormick & Co., Easton, Penn.; part of 1 to Kefauver & McLaran (the other part not yet let); part of 8 to Jas. F. McCabe.

The cutoff work includes several revisions of the location of the present tracks, as at Doe Gully and at Paw Paw.

*From data given by J. Hampton Baumgartner, Publicity Representative of the Baltimore & Ohio R.R. Co., Baltimore, Md.

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Horace Greeley Burt

Horace Greeley Burt, whose death was noted in our issue of May 22, was one of the many prominent railway engineers whose experience included both the engineering and operating departments of railway service.

His railway career began when he was 19, for in March, 1868, he became a rodman on the surveys and construction of the St. Louis, Vandalia & Terre Haute R.R. From December, 1869, he was engaged on railway location and construction work in Kansas until he entered the University of Michigan in the winter of 1870. After graduating (1873) he went with the Milwaukee & Northern R.R. for a few months, and then entered the engineering department of the Chicago & Northern Ry., where he remained for nine years and rose to be Chief Engineer. He then entered the operating department and from 1882 to 1888 was Division Superintendent; then he became General Manager of the Fremont, Elkhorn & Missouri Valley R.R., until July, 1896, and of the Chicago, St. Paul, Minneapolis & Omaha Ry., until 1898. Both of these roads are part of the Northwestern System, and in 1898 he became Third Vice-President of the Chicago & Northwestern Ry., in charge of traffic.

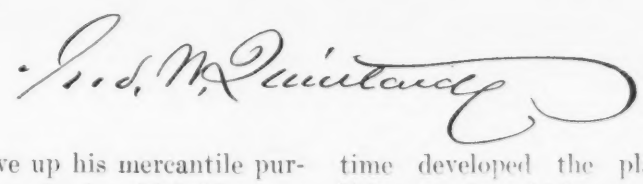
In January, 1898, he was made President of the Union Pacific Ry., and held this position until 1904. During his term of office very extensive reconstruction and improvement works were carried out over the entire line. He then took up private practice as a consulting engineer, and opened an office in Chicago in 1905.

The Chicago Association of Commerce in 1911 organized a Committtee on Electrification of Railway Terminals, for the purpose of investigating the problem of applying electric traction to the vast and intricate rail-

way terminal system of Chicago, and also the problem of smoke abatement. Mr. Burt was appointed Chief Engineer of this committee, at the suggestion of Dr. W. F. M. Goss, of Purdue University (who was a member of the committee), on account of his qualifications both as an engineer and an administrator. This appointment was made in April, 1911, and Mr. Burt was in active charge of the work of the committee until the time of his death.

George William Quintard*

George William Quintard, whose death, at the age of 91 years, was briefly noted in our issue of Apr. 10, was prominently identified with the iron and steel shipbuilding industry of America almost from its very inception. Mr. Quintard was born in Stamford, Conn., Apr. 22, 1822, and came from a family of French descent, which had been prominent residents of that town for several generations. Isaac Quintard, the father of George W., was a merchant of Stamford.



After attending the public schools until he reached the age of 15, Mr. Quintard went to New York, where he found employment as clerk in a prominent grocery house. Mr. Quintard saved his earnings, and after five or six years of labor in a subordinate position was able to embark in business on his own account.

On Feb. 15, 1844, he married Frances J., a daughter of the late Charles Morgan, founder of the Morgan Line of steamers, and this circumstance eventually gave another direction to his career. He had already shown himself to be a capable man of business, and in 1847, at the age of 25, he gave up his mercantile pursuits to enter a new field of enterprise in which his energetic father-in-law had already made a reputation.

Mr. Quintard identified himself at that time with T. F. Secor & Co., owners of the Morgan Iron Works, on the East River, New York City. This establishment was engaged in the manufacture and repair of engines for steamboats and ocean steamships, and he found here a congenial field for the exercise of his abilities. In 1850 he became one of the proprietors, and in partnership with Charles Morgan, remained in active management until 1867.

*Data furnished by George Quintard Palmer, President of the Alberger Condenser Co., New York City.

At these works Mr. Quintard built a large number of what were considered, in those days, ponderous engines for coasting, lake and river steamers, mainly of the walking-beam type, also engines for ships of war, for both American and foreign governments. During the Civil War these shops were of great service to the government authorities who employed them to construct the engines of the following naval vessels: the "Onondaga," "Wachusett," "Seminole," "Muscoota," "Chenango," "Ticonderoga," "Ammonoosuc," "Katahdin," "Ascutney," "Idaho," "Tioga" and the "Kineo."

During his connection with the Morgan Iron Works, Mr. Quintard also built the engines for many famous steamers, a few of which were the following: the "Golden Rule," "Manhattan," "Albemarle," "City of Hartford," "De Soto," "Hatteras," "Peiko" (China), "Yang See" (China), "Fah Hee" (China), "Granite State," "San Francisco," "Robert Fulton," "New Brunswick," "Continental," "Villa Clara," "Cosmopolitan," "Commonwealth," and the Lake steamers, "Southern Michigan," "Western Metropolis," "Northern Indiana" and the "Crescent City."

In 1867, Mr. Quintard sold the Morgan Iron Works to John Roach, the noted shipbuilder, in order to devote his attention to the New York & Charleston Steamship Co., of which he was President and part proprietor.

In 1869 he established the Quintard Iron Works at the foot of 12th St. and the East River, New York City, which was only a few blocks above the Morgan Iron Works. At the Quintard Iron Works, he resumed the construction of marine engines and machinery, and in a short time developed the plant into an extensive establishment, in which were constructed some of the engines for the more modern Navy and merchant marine.

About 1890, Mr. Quintard retired from the active management of these works, and during the latter part of his life his time was occupied in the management of corporations in which he had investments, and into the direction of which he had been invited, owing to his financial ability and upright character.

He had been a director in the Manhattan Life Insurance Co., the Butchers' & Drovers' Bank, the New England & Nova Scotia Steamship Co., the Eleventh Ward Bank, the New York, Lake Erie & Western R.R., the Pennsylvania Coal Co., the Atlantic Mutual Insurance Co., the

State Trust Co., the Union Ferry Co., and the Leather Manufacturers' National Bank.

It fell to the lot of Mr. Quintard to become one of the assignees of his old friend, John Roach, whose fortune had been impaired by the hostile action, since repented of, by the Navy Department under William C. Whitney, at the time Mr. Roach was constructing the first ships of the new Navy. Mr. Quintard with his colleagues was able to extricate the affairs of Mr. Roach from difficulties, reopen the Morgan Iron Works and the shipbuilding establishment on the Delaware River, both of which had been closed, and place them once more on a prosperous footing.

Mr. Quintard served his fellow citizens in the positions of Emigration Commissioner and Park Commissioner, but declined all other tenders of public office.

A few years ago he resigned from most of his business connections and clubs, and the latter part of his life was spent between his farm in the country, and his town residence.

Burning Low-Grade Fuels on Locomotives*

By Samuel B. Flagg†

The dividing line between lignitic and sub-bituminous coals and also between sub-bituminous and bituminous coals cannot be sharply drawn. In general, however, lignitic coals are characterized by a high moisture and high volatile matter content, a fairly low percentage of ash, and a low heat value. They are of a brownish color, have a woody appearance as regards their structure, and give up their moisture and disintegrate rapidly upon exposure to the atmosphere.

The lower grades of sub-bituminous coal differ from the lignites mainly in appearance. The better grades, however, have a much lower moisture content and higher heat value; in fact, the heat values of some of them are considerably higher than those of many of the bituminous coals. Even these high grade sub-bituminous fuels, however, have the same tendency to disintegrate upon exposure to the air and to heat in a furnace. Another characteristic feature of both the lignitic and sub-bituminous coals is their liability to heat in the pile or bunker and to take fire spontaneously. One point in favor of the sub-bituminous coals is the freedom from clinker troubles.

It has been estimated that of the coal easily accessible and still remaining in the coal fields of the United States 33% is represented by the lignitic and sub-bituminous deposits. There seems to be no question that these coals will be used in increasing quantities. There is doubtless much to learn relative to the proportion of grate area to heating surface that will give best results with different coals. Some of the roads are using this sub-bituminous fuel on the same engines that at other times burn bituminous coal. The probability of a marked increase in the use of the true lignites in the near future is not great.

SPARK-ARRESTER DEVICES

In some sections the greatest problem connected with the use of sub-bituminous fuels has been the preventing of spark troubles. Because of the high drafts necessary and the absence of any coking properties of the fuels, large quantities of sparks are carried out of the firebox. These must be caught by some arrangement of screens, or so delayed in passing out that they are cooled down to a temperature at which they will do no harm, or they must be broken up into particles of such small size that they will be dead before reaching the ground. The first attempts to solve this problem were made with different sizes and arrangements of screens and usually included two screens for the gases to pass through. It was usually found, however, that one of the screens clogged and prevented the free steaming of the engine.

By using a single screen properly set, most of the clogging trouble can be done away with. Screens set horizontally will, with some forms of stacks, remain clear longer and give less trouble than if set on an incline; and small-mesh netting of small wire is more satisfactory than that made of large wire.

A front-end arrangement designed to reduce in size the sparks or cinders, and also delay their delivery from the stack, is shown in Fig. 1 (American Locomotive Co.). A number of locomotives have been equipped with this device and have been in service for two to four years. It is stated that the sparks are reduced to such small size that they give no trouble.

The sparks upon leaving the front end of the flues strike the baffle plate A and are deflected downward. In front of the baffle plate is a table plate with an adjustable end B, under which the sparks and gases pass. Deflector plates attached to the boiler front and to the top and bottom of the smoke arch, and a flat plate attached to the front end door, again deflect the gases and solid particles, after which they pass through a netting C, of 4x4-in. mesh, which surrounds the vanes, D. These vanes are separate castings attached to the bottom end of a bell-shaped casting suspended from the base of the stack and set with about a 2-in. opening between them. In passing between the vanes the particles are further pulverized and by the time they leave the stack are harmless.

Another front-end arrangement for sub-bituminous coal burners is shown in Fig. 2, and has been used principally in locomotives burning coal from the Roundup district, Montana (C., M. & St. P. Ry.). The sparks do not pass through any screens or netting, the success of the device depending rather upon the delayed delivery of the solid particles, thus allowing them time to cool down. A roughened plate of ¼-in. steel A, is attached to the regular baffle plate at the front flue sheet. This, together with the table plate B fastened to a flange on the upper end of the exhaust pipe,

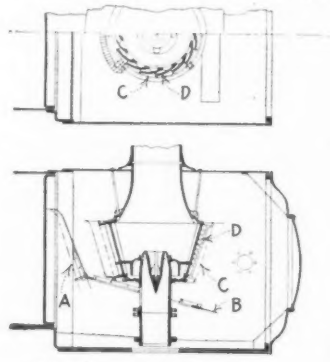


Fig. 1. American Locomotive Co.

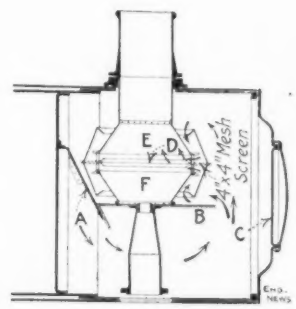


Fig. 2. Chicago, Milwaukee & St. Paul Ry.

Spark-Arresting Devices for Locomotives Burning Lignite

deflects the sparks and gases, causing them to pass to the front of the smoke-box. A liner plate C, attached to the front-end door serves as another deflecting plate.

The paths of the sparks and gases are indicated by the arrows. The top and bottom sides of the plate D, midway between the two petticoat pipes E and F, are faced with 4x4-in. mesh No. 8 netting, shaped as shown. Sparks in passing between the housing surrounding the petticoat pipes and entering the latter strike these screens and are broken up into smaller particles before being discharged.

The Promotion of Traction-Engine competition has been undertaken by the American Society of Agricultural Engineers, which is now ready to furnish, during the year, technical assistance in the management of competitions of traction engines for general purposes. At the last annual meeting of the Society it was voted that a special committee should hold itself ready to assist, on request, in the technical management of such competitions during the coming season. This committee has been appointed and will discuss, with managers of fairs, expositions and apparatus shows, the technical aspects of such questions as where competition had best be held and what land, buildings, equipment and funds are necessary. Preparation of rules and regulations for the contest and supervision of testing and judging will be undertaken by the Society, but it will not undertake to record entries and make local arrangements. Inquiries should be made of the secretary of the Society, I. S. Dickerson, Urbana, Ill.

*From a paper read at the annual convention of the International Railway Fuel Association, at Chicago, May 21-24, 1913.

†U. S. Bureau of Mines, Pittsburgh, Penn.

EDITORIALS

The complacency with which some of us have assumed that America led the world in development of electric lighting, among other things, is rudely shattered by a recent editorial in a British contemporary* which tells us how crude our systems must be and how much more satisfactory are the systems over seas. It is of no avail that we consider the supply networks in our large cities on which voltage has not been off for years, or the sizzling potentials of our long transmission lines, our staggering production of lamps and machinery. All such considerations fail, for our systems have been convicted on the evidence of one of our own number. It seems that there has fallen into the hands of this contemporary a copy of an American technical journal published to further the interests of a group who feel that the large central station cannot compete in economy and satisfaction with a moderate-sized isolated plant. Possibly our transatlantic friends suffered a peculiar lapse and swallowed all the statements which they read without the proverbial and much needed grain of salt. Anyhow, bearing in mind the recognized tendency to concentrate the generation of electrical energy, our British cousin breaks out in a strain of pardonable pride, thus:

> We gather from the columns of this contemporary that central-station service, presumably in America, has not reached the same standard of reliability as now prevails throughout the length and breadth of the British Isles. . . .
>
> Presumably, both steam and hydraulic stations have been subject to somewhat serious interruptions, if we may take the word of our contemporary, and this fact has thrown discredit upon public electricity supply, while at the same time enhancing the claims which can be put forward on behalf of isolated plant. . . . .
>
> Whether or not it is a matter of temperament or natural ability, or even an indigenous aptitude for carrying out good work, we seem to have been able to establish a thoroughly reliable public electricity service, and one which we presume our American friends would like to possess. We do not say this in any boasting spirit. The result is doubtless due to that peculiarly British trait of thoroughness which evidently only comes of long experience.

We have heard that fine lawns, such as are found on a few estates in England, are to be secured only by centuries of continued rolling, but when it comes to building power plants we have cherished an idea that our experience dated back as far as anybody's.

*London "Electrician," May 16, 1913.

The First Large Freight Yard to Be Operated by Electricity

One of the most difficult problems in connection with railway electrification is the electric operation of switching yards for freight service. Where the third-rail system of operation is employed, it will be conceded, probably, that operation of a freight yard by electric power is out of the question. The work of yard men is dangerous enough at the present time; and if we were to add to present dangers the necessity of keeping clear of a labyrinth of highly charged third rails, extending all over the labyrinth of tracks, it may well be expected that the result in casualties would shortly result in a public outcry and consequent legislation compelling the abandonment of the system. All this is aside from difficulties in connection with the interruption of the third rail in passing switches, which would always leave chances of a train coming to a standstill when the locomotive was not in touch with its current supply.

With the high-tension overhead system of electric distribution, however, such as is now in use on the New York, New Haven & Hartford R.R. from New York to New Haven, it becomes possible to equip a freight yard for electric operation by suspending a network of electric conductors overhead. This has now been done for the New Haven Ry. at its Harlem River freight terminal in the northern part of New York City. This terminal covers an area of 200 or 300 acres and its tracks have a total extent of 86 miles.

The steel towers which support the overhead network are spaced about 300 ft. apart longitudinally. Cables from the tops of these towers span 8 to 10 tracks and support at each track a single line of 7/8-in. steel cable. This cable carries a copper conductor and below it is the steel conductor wire against which the pantograph on the electric locomotive makes contact. Steel deflectors are used at the switches to give a smooth and continuous contact with the pantograph. The standard position of the contact wire is 22½ ft. above the top of the rail which gives a clearance of about 2 ft. over the head of the average brakeman standing on top of the cars. While this is rather closet to a high-tension electric conductor than is exactly pleasant, it is stated that among the 500 men employed in the yards since electric operation began, no casualties from electric shock have resulted. At present there are seven electric switching locomotives working in the yards and as many steam locomotives. It is expected that within six months additional electric locomotives will be put in service so that the entire yard will be operated by electricity.

Figures as to the cost of equipment of the yard for electric operation are not yet made public. We believe, however, in view of the past experience of the New Haven road with electric operation, that railway men in general will scrutinize very closely the operation of the Harlem yard before deciding to accept such a system for use elsewhere. It will, of course, be admitted that the elimination of smoke and escaping steam and the noise of the exhaust of switching locomotives is a great gain to the adjacent territory. It is stated that appartment houses are being erected in the district near the Harlem yards which has hitherto been considered unavailable for residence purposes. On the financial side, however, the case for electric operation is far from clear; and the financial side is one which no railway is overlooking in these days. Attention may well be directed not alone to the first cost of equipping a yard with the great labyrinth of towers, cables and contact wires, but to the cost of maintenance and depreciation of this overhead network. The probability seems strong that the life of this overhead network, exposed as it is to all the cor-

rosive influences of the weather and accessible for repair and maintenance in the way of painting, etc., only with much expense and risk, will be a comparatively short term of years. This means, of course, that a high percentage must be assumed for depreciation in figuring total cost.

There seems to be no question also that a very much higher standard of track maintenance will have to be kept up with electric operation in order to keep the return track circuits in good condition. Railways have been accustomed to economize by using second-hand rails in yard track and expending very little work on track maintenance on long sidings over which no movements at high speed occur. Electric operation will mean that more money and probably a good deal more money will have to be spent on yard-track maintenance.

Reverting again to the question of danger, it is said that the overhead network is arranged in independent section. By throwing a switch, the current supply can be cut off from any unit section so that repairs to the overhead network can be made with safety. This is, of course, a necessary feature and will give no trouble if the repairs to be carried out involve something which can be done in a short time. If and when, however, repairs become necessary which will involve a day or several days to accomplish, the interruption to the business of a crowded yard might be a very serious matter. It will be worth investigation also as to whether the electric operating results in greater damage to cars and to lading than the operation with steam locomotives. With steam or compressed air it is easy to graduate the applied force. With electric power, however, the general tendency is to start up with a jerk.

Besides the large Harlem yard, the New Haven has also electrified its freight yards at New Rochelle, Mount Vernon, Woodlawn and Stamford and intends to transform its other freight yards all the way to New Haven. The results of its experience, financial and otherwise, in this new departure will be watched with critical interest by railway officials the country over.

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Municipal Participation in Railway-Terminal Projects at Chicago

The railway-terminal problem in Chicago has entered a new phase of development, which seems to promise the review of present and future plans by an independent body which will consider them from the point of view of the city as well as that of the railways. This is a very desirable step in view of the importance of proper relations between the location and arrangement of railway terminals, the systematic development of municipal improvements, and the convenience of the traveling public.

This situation has developed as the result of an application to the city for the necessary authority to rebuild the present Union Station at approximately the existing location but on a much larger site, which proposed reconstruction includes also a revision of the adjacent freight terminals. This station is owned by the Pennsylvania R.R. Co. and is used by four railways. It lies on the west bank of the Chicago River and (including the station yard) extends from Jackson Boulevard to Madison St. (a distance of three blocks). When the railway company's plans for reconstruction were submitted to the city authorities, with request for an ordinance for certain closing and changing of streets, opposition was at once evident, and there has been a growing agitation against the approval of these plans. The opposition comes from various sources, some interested and others disinterested. Among the main points are that the design does not give sufficient consideration to the municipal aspect of the work, that the new plan would perpetuate the present undesirable feature of a line of railway property blocking the westward growth of the business portion of the city, and that it would perpetuate the present unsystematic arrangement of terminals and passenger stations.

As might be expected, the opposition is not united as to the proper action to be taken. One group of opponents declares that the new station should be located at 12th st., about a mile further south, in order to conform with certain plans for the city's development, to group all the railway-terminal stations, and to eliminate the present restriction to the city's growth. Another group considers that no such individual station should be built, but that all passenger and freight terminals should be combined in one vast station, in the neighborhood of 12th St.

At various public meetings, the discussion of the plan now proposed by the Pennsylvania R.R. has been taken up mainly by those interested either in the railways, in the various private or individual terminal projects, or in plans for the city's future improvement. From this presentation of these diverse interested views there has arisen the suggestion that no railway-terminal project should be approved by the city until it has been considered by a competent and disinterested commission that will consider it in its general relation to the city and the public. This is a very reasonable position, and it is to be hoped that such a method will be carried into effect, for however good the present plan of the railway company may be in itself, the fact remains that it has been prepared entirely in the interests of the railway company, and without regard to the railway situation as a whole.

The Board of Direction of the Western Society of Engineers has passed a resolution recommending that before the city grants an ordinance to any railway for changes in any of the present terminals (passenger or freight) a commission should be appointed, having special knowledge of the problems involved, to assist the city council in arriving at a proper decision. The Chicago Architects Business Association has passed a somewhat similar resolution, but recommending further that the commission should be composed of eminent engineers and architects who have no financial interest in or connection with any railway system.

The present railway-terminal system of Chicago is unsystematic in the extreme, and one of its worst features is that a great area of land in the heart of the city (which should be of high value) is occupied by freight tracks and freight sheds. The property cannot be developed, its undesirable character or occupation tends to lower the value of adjacent property, and by separating the central part of the city plan from its outlying districts it seriously hampers the proper growth and extension of the business district. Each railway has its own yards, sheds and other facilities, and there is no

attempt to harmonize or coördinate these facilities to promote the efficiency of the Chicago railways freight service as a whole. Some previous discussions of this matter will be found in our issues of May 9, 1912, and Feb. 27, 1913.

At the present time there are six passenger terminal stations in Chicago. Two of these are of modern construction, and the reconstruction of three others is under consideration. Each of the various plans for the several stations has been prepared entirely with a view to the requirements and ideas of the railways concerned in its use. The relation of each station to the municipal aspect of the matter has been practically ignored, as has been the question of relation to other terminal stations and railway systems. When the plans have been completed by the railways and their representatives, the city is simply asked to pass the necessary ordinances (for closing streets, etc.) and to issue the necessary construction permits. In addition to the railway plans for different stations, plans have been proposed by private parties at various times for the establishment of either one vast station for the use of all the railways, or else a group of adjacent stations each to be used by a certain group of railways. While these private plans present certain desirable and advantageous features, and include usually some consideration of the municipal side of the matter, they represent individual ideas only, and are likely to be open to objection from both the municipal and the railway sides of the question.

The city is by no means free from blame in the present situation. It has not attempted to impose its views or to make any representations in regard to plans which were known to be in preparation by the railways, although the advantages of coöperation should have been evident to the city authorities. And in the present case, it was only when the completed plans were submitted by the railway and objections were made to them by various parties, that the city authorities took any steps to consider the matter. The city has been delinquent also in failing to secure the provision of convenient local transportation routes serving the existing six stations. Between some of these stations there are no street-car routes whatever, although the city exercises control over the street-railway companies and could have long ago required the construction and operation of street-car lines on such routes.

This situation is paralleled in the Pennsylvania station in New York City, which, although projected in its present form nine years ago and opened for service nearly three years ago, is still in a peculiarly isolated zone, as far as rapid transit is concerned. That it is situated on a new subway line authorized only this year to be in operation possibly by 1917 is a measure of the time lost by lack of coöperation and municipal initiative.

In view of the importance of the relations between the railways and the public, and between the railway and municipal facilities, it seems very desirable that the problems affecting the new Union Station at Chicago should be carefully considered by some disinterested and expert authority before any plan is finally authorized. Such a commission would receive and weigh the various arguments presented, and should be able to arrive at some conclusion which would equitably adjust the matter with due regard to the city, the public and the railways.

What Is the Matter with Irrigation?

As those of our readers familiar with the conditions of engineering work in the far West are only too well aware, irrigation enterprises are, comparatively speaking, at a standstill. This is not because of lack of opportunity. There are still plenty of places where, by the construction of reservoirs that could store the spring floods, land which is now worthless desert could be converted into fertile and profitable fields.

But when the enthusiast who sees the possibilities of such a situation goes to a banking house in the East and asks it to finance the work, he is met with a reception compared to which a journey of polar exploration would be tropical. It will not do to blame the banker for this, because he knows by experience that irrigation bonds are today practically unsalable. Not a few banking houses have suffered in purse and in reputation because of the irrigation enterprises which they have financed in the past. It is worth while asking, therefore, why irrigation is unprofitable. It is true that many irrigation projects have been run by irresponsible men who have sought merely to sell stocks and bonds with little care whether the purchasers ever received any return or not. This, however, is only a part of the explanation why irrigation securities are shunned by investors. Wild-cat mining stocks innumerable have been sold in all parts of the country; but a valuable mine or valuable mining stock is not thereby rendered impossible of sale.

The trouble with irrigation enterprises is that even when they have been honestly and intelligently financed and managed, the final result has usually been either a loss to the investors or a return too small on the whole to pay for the risk and trouble. There are, of course, a few notable exceptions to this general rule. We are speaking in a large way now, and dealing not with particular enterprises but with the general run of well managed irrigation projects under private enterprise.

It is important to inquire the reason why there has been such general disappointment in the final outcome of irrigation work. According to information from reliable sources, the reasons why irrigation projects have so generally failed may be stated about as follows: There are enormous areas of arid land in the West which in their original state can produce nothing, but which with irrigation water properly applied can produce such crops that the lands will be worth $100 to $200 per acre, and in exceptional cases even more. The cost of building dams, storage reservoirs and canals to bring the water to such lands may be taken as averaging in the neighborhood of $50 per acre. As the final value of the land will be two or three times what it will cost to bring the water to it, there is apparently a very large margin of profit.

If it were possible for the irrigation financier to apply the water to the land, and then sell it all off to solvent purchasers at $100 per acre or more, his prospective large profit would be realized. There is, however, one essential element in irrigation development which many shrewd capitalists who have undertaken irrigation work in the past twenty years have overlooked, and that element is the character of the purchasers of the irrigated lands.

There are no doubt several millions of people resident in towns and cities who would be very glad to try the experiment of settling on an irrigated farm and enjoying all

the delights so picturesquely set forth by the glowing prospectus writers, but a very small percentage of these people have the ready money to buy an irrigated farm at $100 an acre, and an equally small percentage would know how to profitably work such a farm if they had it.

The present situation is that the supply of irrigated land offered for sale has far outrun the supply of intelligent farmers who desire and are able to purchase such lands, live upon, and work them. In British India the irrigation works undertaken by the Government have been uniformly successful and have invariably returned a handsome margin of profit on the cost of the work; but British India is swarming with peasants who ask nothing better than the privilege of living upon and working land which yields them a bare subsistence. There is the greatest possible contrast between the irrigator of British India and the Americans in the far West whom promoters of irrigation projects desire to place on the land.

A very large proportion of land buyers in the West have made money by land speculation. If the manager of an irrigation project can persuade land speculators to buy up lands at $100 an acre on the ground that they are likely to be worth $150 to $250 in the course of two or three years, he is a lucky fellow. In fact, we are informed that where irrigation enterprises have turned out profitably to their promoters and investors, it has generally been because those in charge were shrewd enough to sell out at a sure profit rather than hold onto the land and wait for a rise.

We should not be understood, however, as stating that there are no substantial intelligent farmers living on irrigated land in the West. On the contrary, there are a very great number of them; but it requires large inducements to persuade enough of these men to move into a new country to fill up at once a large irrigation project.

The development of an irrigation project is similar in many respects to the development of a tract of suburban land. Many an investor has learned by dear experience that it is impossible to quickly build up a suburban tract of large size and sell all the land at a large profit to *bona fide* home builders.

On the face of things there seems to be an enormous profit between the cost of a large tract bought by the acre and the price of the same land when cut up into building lots and sold to home buyers; but if the development is to come naturally, it will be found that instead of selling off all the lots in two or three years, it may be a matter of ten or twenty years or more before even two-thirds of the lots can be sold to home seekers. During all this time, interest on the investment is piling up and so are assessments for various street improvements, and the profit of the suburban land developer not infrequently turns out to be a minus quantity.

Conditions very similar operate to cut down the profits of an irrigation enterprise. In the first place if the works for water storage and distribution are of magnitude, two or three years or more may be required for their construction and during all this time interest charges are accumulating. The rate of interest on irrigation securities when they can be floated at all is seldom less than 6%; and when commissions to the bankers, etc., are deducted, the actual rate of interest paid is often 7% or more.

With the works completed, the next problim is to put the land under irrigation. Of the buyers of the land, only a small percentage are able to pay for their lands in cash. Even those who have capital have to expend it in buildings, in farm machinery, in the purchase of stock and in preparing the land for irrigation. A considerable part of the settlers will prove failures through shiftlessness, intemperance, ignorance, etc. Meanwhile the whole irrigation plant must be operated and maintained at heavy annual expense. Thus it has very often resulted, even with an irrigation enterprise honestly built and financed, that for two or three years after its completion it was a case of a good deal of money going out and little coming in. A graphic picture of the course of events on many irrigation projects is given in the following, furnished to us by an engineer thoroughly posted in irrigation development:

> An irrigation system depends for its success upon hundreds of individual farmers who cannot be controlled and organized as are laborers employed in the factory. Each farmer must learn individually, sometimes through years of experience and frequent failure, how to successfully subdue and cultivate the ground.
>
> The lands may be sold immediately after the system is built as the result of attractive advertising; but relatively few of the persons who obtained farms will be experienced farmers. Thousands of acres may be provided with water, but at the end of the first year, it will be found that a very small percentage has actually been properly leveled and prepared for cultivation of crops. Many of the farmers have made mistakes and comparatively few can show much return for their work.
>
> The next year a little larger area is in cultivation and so on. Then there comes a good year with abundant crops, which glut the market so that the farmer gets small return. So it goes, with ups and downs, year after year. On the whole there is progress, but in the meantime, the farmers have not been able to keep up their payments. Interest has been defaulted; the bondholders have been forced to take the property, reorganize and start over again, the first investors usually losing all they have put in.

Nor are these the only difficulties which the promoter and manager of an irrigation enterprise must face. A good many engineers are of the opinion that it is easier to tackle all the engineering problems in building an irrigation works than it is to solve the human problem of managing the works after they are completed and keeping peace and harmony between the various water users.

Where an irrigation plant is permanently operated by a private corporation, there is apt to grow up antagonism of the water users toward the company. Such antagonism toward corporations operating public utilities is a notable feature everywhere; but nowhere is it more injurious and dangerous to public welfare than in the case of irrigation companies. The welfare and very existence of the whole community is dependent on the supply of water available for irrigation. The whole community is endangered if the company which administers this supply becomes bankrupt so that it cannot properly maintain and operate its plant.

Because of this very general antagonism between the farmers and the corporation which controls the supply of water to their lands, the plan of having the farmers themselves own and manage the irrigation works on which they depend has been generally favored and is probably, on the whole, the best plan of control. Nevertheless, these water users' associations also have their troubles. Personal jealousies and feuds and local politics too often result in incompetent men being placed in control of the works; maintenance may be neglected and

favoritism in the distribution of water may lead to litigation and loss.

Turning now to the reclamation of arid land by the Federal government, through the U. S. Reclamation Service, it will be apparent that while this work is free from the financial difficulties that hamper work carried on under private enterprise, it has the same sort of difficulties to contend with with respect to securing the settlement on the reclaimed lands of the right sort of successful farmers.

The Reclamation engineers have made good by building works on the various projects which are on the whole admitted, even by their critics, to be well designed and well executed. The financial returns from the sale of the reclaimed lands to settlers, however, have fallen far below the amounts which would have been received by this time if the original plan had been successfully carried out.

The reasons why the settlers have in many cases failed to pay the installments on their lands as they became due are substantially the same as those which have caused disaster to many private irrigation companies, as related above. The government, however, is even more handicapped in the disposal of its land than is the irrigation corporation. Lands under a government Reclamation project must be sold, under the law, to whoever applies for them at a price fixed to cover the actual cost of supplying water. The sum is payable in yearly installments and no cash down is required. Under these conditions a large portion of the purchasers of lands on Reclamation projects have been land speculators rather than *bona fide* settlers and farmers. They have exercised their right to purchase under the law on the chance that they might dispose of their right to the land to someone else at a profit before payments became due.

According to our information, a large portion of the land to which water is supplied on the Federal Reclamation projects is not under cultivation because those who hold title to it have not actually settled upon it and gone to farming. Another large proportion of settlers who are living upon the land lack the capital or the ability to successfully work their holdings. The result in either case is that payment of the annual installments to the Government is not made when they come due. Further, many settlers of this class even when able to pay have refrained from payment in the hope that Congress might pass legislation which would give them further time for payment. The example of such land owners, of course, has its influence on the other class of settlers who are successfully working their lands. They, too, delay payments in the hope that something will result to their advantage.

Notwithstanding these drawbacks, there are many settlers who have paid the installments on their lands as they came due and a large amount has already returned to the treasury from the completed irrigation works and is available, according to the original plan, for investment in new works. If it once becomes definitely known that Congress will not alter the terms of payment originally fixed, there will doubtless be great acceleration in the payment for water rights on the Federal works.

It is of interest to contrast the difficulties above set forth with the sale and settlement of irrigated lands in the United States and the methods which are being pursued by the Canadian Pacific Ry. Co. in placing settlers upon its lands in the Canadian Northwest. The far-sighted managers of the Canadian Pacific know that the prosperity of the great network of railway lines in the fertile new empire now being created in western Canada depends upon the character of the people who are brought to settle upon the tributary lands. The company received by land grant from the Dominion enormous areas of land, much of which it has held up to the present time instead of selling it at the nominal prices at which all public lands were held throughout the West twenty-five or more years ago.

To make many of these tracts located in the arid regions cultivable, the railway company has engaged in irrigation work on a large scale; but instead of selling these lands to whoever may come, the railway company has adopted the policy of carefully selecting its settlers and future patrons. Agents of the company travel through eastern Canada and the eastern United States and select in country towns young farmers who have a good reputation for honesty, energy and success in farming. After thoroughly investigating such men, the company makes them a liberal offer to move to lands in the Canadian Northwest. We understand that to such men the entire capital necessary to make a start is furnished. The company erects farm buildings, breaks up the land and puts in a first crop so that the farmer from Ontario or New England when he moves to his new home and goes to farming has the great advantage of a complete going farm plant without undergoing for years the struggles and hardships of the pioneer life. He pays for his farm and home and stock year by year as he earns profits.

By thus carefully selecting its settlers, the company insures not only financial success for them and for itself, but good social conditions in the new towns and communities it is creating. The emigrant moving to the territory knows that his life and property will be safe in his far-away new home.

Of course it takes a very large amount of capital to finance land development in this way, but the capital is invested in a manner which makes the return upon it practically secure.

It is of interest also to refer to the progress in irrigation which is being made in British India. A recent Indian bluebook gives the statistics of this development as follows:

In British India the government has built and now operates some 59,000 miles of main and branch irrigation canals. These supply water to over 48,500,000 acres of cultivable land. The net earnings of the Government last year from the irrigation works which are classed as "productive" (in distinction from protective works such as levees, etc.), is given as 8.81% on the total capital outlay, which up to the present time is in the neighborhood of $175,000,000. This total outlay, however, includes works which are still under construction and not yet completed, so that they are not yet yielding revenue. If the completed works alone are taken, the average earnings last year on the capital invested were 10.27 per cent.

Additional irrigation works are under examination by the Indian government, designed to furnish water to nearly 30,000,000 acres of land additional, at a total capital outlay of about $200,000,000, on which the estimated annual earnings are over 7 per cent.

The tendency is, of course, to blame the engineer for

the disappointing financial results of recent irrigation enterprise in the United States. The above review, however, should convince any intelligent person that it is not necessary to assume any defective work by the engineers responsible for the design and construction of American irrigation works to account for the slough in which irrigation finance has landed.

There is no reason to believe that the reservoirs and canals built by the U. S. Reclamation Service or by the reputable irrigation companies are not the equal of similar works in Canada or in India. In Canada, however, as shown above, it has been deemed as necessary to invest capital in establishing desirable settlers upon the land as to build the works necessary to supply it with water. In British India the irrigation engineer has the advantage of very low-priced labor; and a swarming population is ready to utilize every foot of irrigated land as fast as the water can be supplied to it.

It is needless to say that we cannot and would not if we could, duplicate in this country the conditions of overpopulation and pressure for subsistence that aid the irrigation engineer in British India to show such large financial returns from his enterprise.

What we should do is to recognize in either private or Government irrigation work that the sale of land to *bona fide* successful farmers is as necessary to the financial success of irrigation work as the storage and distribution of the water itself, and that properly directed expenditure to that end should be considered a necessary part of the cost of irrigation work.

LETTERS TO THE EDITOR

Flange Width in T-Beams on Tile and Concrete

Sir—Answering the inquiry as to the proper flange width to be assumed for tile and concrete T-beams, made by Ernest McCullough in ENGINEERING NEWS, May 22, 1913, p. 1078, information will be found on p. 110 of the *Proceedings* of the 29th Convention of the Indiana Engineering Society, 1909, where the writer presented tests of hollow-tile reinforced-concrete floor sections.

Table I, reproduced herewith, shows the shear values

RELATIVE STRENGTH IN SHEAR OF HOLLOW TILE REINFORCED-CONCRETE BEAMS

Series	No.	Reinforcement	Max. shear (Lb. per sq.in.)	Ratio	Failure
A	(1)	Plain	295	53	Shear
	(2)	Bent rods	430	77	Shear
	(3)	Bent rods and stirrups	560	100	Shear
B	(1)	Plain	269	74	Shear
	(2)	Bent rods	303	84	Shear
	(3)	Bent rods and stirrups	360	100	Shear
C	(1A)	Plain with tile	232	100	Shear
	(2A)	Plain with tile	194		Shear
	(1B)	Plain without tile	144	66	Shear
	(2B)	Plain without tile	145		Shear

obtained. The beams comprised one rib with one-half a tile on each side and 2½ in. of concrete on top. The tile varied from 6 to 12 in. in depth. The full data of the tests will be found on p. 110 in the article cited.

W. K. HATT.

Purdue University, Lafayette, Ind.
May 26, 1913.

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The Richmond, Va., Bridge Competition

Sir—I wish to express my approval of your criticism in ENGINEERING NEWS of May 29, 1913, p. 1134, of the manner in which the competitive plans for the proposed bridge and viaduct approaches for Richmond, Va., has been conducted.

Seeing notice that competitive plans would be received until Apr. 15, I wrote to the City Engineer in the early part of February for information and profile of location. I received within a few days blueprint of profile and requirements of the Administrative Board governing the filing of designs and plans. I immediately went to work on a design, giving considerable thought to whether it would be best to submit a design with the cost of construction as low as possible, or something ornamental.

After I had plans worked out and almost ready to submit I had occasion to talk with a prominent engineer who had entered such competitions before and he gave such good reasons for not entering the competition I dropped the matter without further work.

I believe a code, possibly similar to the one formulated by the American Institute of Architects, would be of much good if it is necessary to have competitive designs. I am somewhat doubtful of any real good being derived from such designs, or at least I cannot see where it justifies so large an expenditure. If it costs the engineering profession 4% of the estimated cost of a structure to get up competitive designs and it only receives 0.4% compensation, who pays the difference? If it is advantageous to have competitive designs on one structure, why not on all?

JOHN R. BAYLIS.

Birmingham, Ala., May 31, 1913.

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One Way to Buy Professional Service

Sir—Congratulations are extended the Engineering profession on the possession of a friend, who offers to its members an opportunity set forth in the following recent advertisement:

COMPETENT SURVEYOR during June (may be college professor, including assistants from graduating class), to survey and plot a tract of 250 acres into building sites, in exchange for board of family and assistants, at first-class summer inn on mountain; 2000 ft. elevation; 100 miles from New York City; charming summer colony. P. O. 911, Eng. News.

There are some in the ranks, who will be presumptuous enough to think that even an inferior surveyor is worth more than his board, even though it be on a mountain top.

CONSTANT READER.

Bradford, Penn., May 26, 1913.

[That is one way to look at it. Another way is to figure

out what the board bill would be per month for a family of nine children at prevailing summer hotel prices. And who knows what unattached heiresses there may be as attractions for the graduates in that "charming summer colony"!—Ed.]

Technically Trained Judges to Decide Patent Cases

Sir—I note an excellent article in your issue of May 8 (p. 958), by Mr. Gilbert H. Montague, entitled, "Some Radical Reforms in the Conduct of Patent Litigation." The present writer, however, believes the real root of the inefficiency of our courts on technical questions has not been brought out in the discussion.

Our Federal judges are men of the highest character and acumen. Their absolute fairness, integrity and honesty is not open to a shadow of suspicion. Modern progress, however, is based, not on the general learning of any particular class of men, but rather on special knowledge fitting a certain class of men to perform with marvelous efficiency and rapidity some special service for the community. The training required to achieve this is the result of lifelong study and practice in this special field.

Let us consider the fitness of the ordinary Federal judge to try highly complicated causes: He is not an expert mathematician, nor is he familiar with mechanical principles, to say nothing of purely technical matters. He would probably be equally unable to appreciate the difference between a staging jack, a mover's jack, a hydraulic jack and a ratchet jack. In other words, the judge, a master in logic and learned in law, is inefficient in his grasp of technical matters because he has not been trained in this line.

In this connection I may quote the remarkable decision rendered in the Circuit Court of the United States for the Eastern District of Texas, Beaumont. Equity case No. 152, and Equity case No. 153, Horace G. Johnston, et al, vs. Southern Wells Works Co. et al:

> The Court: In each of these cases I render judgment for the defendants. I entertain very grave doubt about what ought to be done in the matter, but I must decide the cases at this term of the Court. They involve some questions about machinery, and I have felt inefficient in the matter. I am sorry that I did not know before I tried the cases that I could summon a jury of skilled mechanics, the law providing for not more than seven and not less than five to decide the issues of fact, but I did not know of this provision of the law until the cases were argued and counsel had left, and I did not discover until they were gone and the trial over that I could avail myself of that source of light. There was nothing then left to be done except to take the briefs and come to the best understanding I could.

Why should we not have specialization along judicial lines? Why should we not have a class of judges who are trained experts to decide technical questions, which in order to decide intelligently require special training along special lines? Indeed, is not our judicial system as far behind the present state of progress in this particular as were the Dark Ages when decision by combat was prescribed or permitted?

Let us consider the *modus operandi* of the trial of an ordinary case of patent litigation, whether under the new rules or the old rules. The case involves special questions of a technical nature. In order to present it properly to the judge, the attorney must, with experts, lay the foundation in his testimony for the production of a brief which will be so comprehensive as to be in fact a treatise covering all of the elementary fundamental principles of mechanics, trade terms, and methods of operation that are involved in the point at issue. This means, frequently, that a case which could be ready for argument with six hours' work, before a judge who is a trained technical expert, will require three to four months' hard work on the part of the attorney, with testimony to the extent of three to four thousand pages, before these points can be properly brought out and the judge given even an imperfect and flimsy substitute for the solid technical training which he should have had in order to fit him to render a fairly intelligent judgment on the case in hand.

Such a condition of affairs is very lucrative to the legal profession, for at the rate of $50 per day to an attorney for preparing an inferior substitute for the technical training of an honest, painstaking judge, he is able to charge his client from five to ten thousand dollars in well earned fees, thus rendering litigation even of the simplest matter, an enormous burden upon the poor but meritorious inventor.

Is it not also a most flagrant and unwarranted imposition upon honest, painstaking, conscientious men, such as the judges of our Federal Courts, to require them to assume the burden of attempting to master the rudiments of the technique, in one case of textile machinery, in another of strains and stresses, in a third of hydraulics, in a fourth of the mechanics of flight, in the fifth of the chemistry of dye stuffs, etc.? It is time that some steps were taken toward reform in the organization of the judiciary to which patent litigation is intrusted.

This suggestion is not made as a carping critic, merely to find fault with the remarkably good work performed by the judges, but from the standpoint of fair play to the judges themselves and with the hope of reducing the cost of such litigation by placing it in charge of such judges as are fitted for their task by technical training, and do not have to be specially educated for each and every case they try, by the slow, tedious, wasteful process of having the attorney get up a digested summary of the principles involved and set forth, the entire literature of each art to which the case under litigation belongs.

It is too much to expect that our Federal judges shall be competent to decide questions involving all the arts, all the sciences and all the trades of the twentieth century. It leads to bad decisions. Why should not a wealthy government like ours employ experts to decide such cases, as has been done and is done by other countries inferior to ours in technical achievement?

These are questions which it seems to me are of vital interest to the engineering profession as a whole, and the free and energetic expression of opinion by the civil engineer, the mechanical engineer, the electrical engineer, the chemist, the metallurgist, and the manufacturer alike, is all that is required in order to bring about a much-needed reform.

We have been accustomed since our boyhood days to see Justice represented as a blindfolded figure holding the scales. Under the new rules, would not our technical justice be equally well represented without the bandage? For with judges who know nothing of machinery set to decide patent causes involving machinery and required to decide these cases expeditiously, or "while you

wait," with judges knowing nothing of chemistry required to decide chemical questions offhand, is not justice blind enough without any bandage over her eyes? Under present conditions would not Justice be better represented by the elusive goddess Fortuna, with the folds of her garments draping a wheel of fortune, a royal flush or a dice and box.

C. A. P. Turner.

Phoenix Building, Minneapolis, May 15, 1913.

NOTES FROM THE ENGINEERING SCHOOLS

University of Michigan—The first annual exhibit of the Engineering Department was given in the buildings of the department May 15 and 16. This exhibit was prepared entirely by students, with suggestions in some cases by members of the faculty. Work done in the departments of civil, electrical, mechanical and chemical engineering and also in forestry and architecture was displayed. The laboratories of the department were kept open with machinery running and experiments of general and popular interest were performed. Many attractive models were prepared which illustrated various engineering problems. The exhibit was widely advertised and it attracted many people from the city and state, the total attendance for the two days exceeding 10,000. The exhibit was generally pronounced a success, and those in charge believe that it gave the people of the state a clearer understanding of the work being done in the engineering department.

One of the most interesting features was a model irrigation and power development, shown in the accompanying figure, as made by students in hydraulic engineering. The model was made of earth on a wood frame 8x12 ft.; there was a difference of 4 ft. in elevation between highest and lowest points. Water was supplied through a ¾-in. hose and carried off by a small drain at the lower end.

Johns Hopkins University—The establishment of a Department of Engineering has been made possible by appropriations of the state of Maryland (special funds for buildings and equipment, and continuing annual sums for maintenance). Postgraduate and undergraduate courses in civil, mechanical and electrical engineering have been arranged, professors have been appointed and plans for buildings and equipment are under way. Up to this time there has been no such distinct department though courses in physics, applied electricity, chemistry, bacteriology and public hygiene, economic geology geological surveying, etc., have always been maintained to present recent advances in science and their industrial applications.

A Model Irrigation and Power-Development Project

(A, mountain; B, crater lake; C, cañon; D, supply canal; E, reservoir; F, arch dam; G, penstocks; H, roads; I, power house; J, river; K, main distributing canal; L, flume; M, power-transmission line; N, check irrigation; O, lateral ditches; P, furrow irrigation; Q, village; R, flood irrigation.

The undergraduate courses are to be of four years' duration and will combine the usual fundamental and cultural subjects with professional studies. English, mathematics, physics, French or German, and mechanical drawing will occupy most of the first year and, with chemistry, will run through the second year. During the last two years the more specialized studies will be supplemented by political economy, philosophy, advanced chemistry and mathematics, biology, etc. In addition to the familiar methods of instruction, it is planned to

make more prominent the study of existing engineering works.

Those who wish to enter these courses must first present evidence of a satisfactory knowledge of mathematics, English, history, French or German, Latin or physics, chemistry or biology, or mechanical drawing. Entrance examinations are required in addition. Each applicant is expected also to furnish a certificate showing completion of a standard high-school course. Applicants who satisfy the regular requirements for admission to undergraduate academic courses of the University will be admitted to the engineering courses.

Under the conditions of the legislative act making possible this departure, one or more scholarships, carrying exemption from tuition and fees, are apportioned to the several counties of the state in proportion to the number of legislative delegates therein. There also are scholarships for each legislative district of Baltimore. Six scholarships "at large" have been established. One scholarship for each such county and legislative district also carries $200 for board and lodging. These scholarships are to be awarded only to those "whose means are such that they are unable to procure a technical education" otherwise.

Electric-Traction Plans of the Norfolk & Western Ry.

The substitution of electric traction for steam on the Bluefield-Vivian (W. Va.) section of the Norfolk & Western Ry., as announced in ENGINEERING NEWS, May 8, 1913, has been further explained by the road's consulting engineers, Gibbs and Hill, of New York City.

The electrified section constitutes practically a separate gathering division for the coal traffic from the Pocahontas region and comprises about thirty route miles or about eighty-five track miles; the division is double-tracked throughout except in the Elkhorn Tunnel, which is single-tracked and with a large amount of third or passing siding track and branches into the coal workings. The grades on the line are heavy, being from 1.5 to 2% eastbound to and through the summit tunnel, a distance of about ten miles, thence the grade falls for about a mile and then rises again at the ruling rate of about 0.4% for approximately 12 miles to the east end of the division at Bluefield. The heavy coal business originates west of the summit and is in large part hauled eastward over the grades above noted. The coal trains originating on the division are filled out generally to a weight of 3250 tons from the various workings along the line and hauled over the grades at a speed of about 7.5 mi. per hr. by three Mallet engines, one at the head end of the train and two pushing. The Mallet engine equipment is used locally on the division in question and under electric operation these engines will be displaced by electric engines, allowing the Mallets to be used on the other regular divisions of the road.

At present the electric service will not touch merchandise freight or passenger traffic, being confined to "tonnage trains" originating on the electrified section. These will be operated by electric head engines and pushers at a speed of about 13 mi. per hr. on the heaviest grade. The number of trains handled up the grade will be about 20 per day, comprising a daily tonnage of 65,000, but the design of electrical equipment will be such that this tonnage can be progressively increased in the future as the occasion requires.

An overhead electrical conductor will be used to convey current to the trains, the local conditions precluding the use of a third rail alongside the tracks. The traction current has not yet been decided upon and plans and estimates are being made for the use of either alternating- or direct-current locomotives according to which design proves most adaptable to the service and cheapest in first and operating costs. Electric power will be generated in a steam power house to be erected by the company at Bluestone, which is on the line of the railway about one-third the way from Bluefield to Vivian; this power house will have an installed capacity at present of 24,000 kw. All work is to be completed for service in the summer of 1914.

The local conditions are considered especially favorable for electric haulage; the traffic is dense and of heavy train units operating at fairly uniform intervals over a section of the main line which is practically a separate engine division at present and can be electrically worked in the same way without increasing the cost of engine service on the other sections of the line. Electric power can be generated at an unusually low cost since excellent coal is obtainable at the point of origin; other conditions, conducive to high economy with electric traction, are (1) a train service such that a minimum of electrical equipment can perform the haulage in practically continuous service, (2) fewer engine crews per train than with steam, and (3) the higher speed of operation over the division which will be nearly double that possible with present steam equipment. Delays due to taking water, coal, etc., in steam operation will also be eliminated and the reliability of locomotive operation will be increased under certain conditions of weather. These conditions result in reduced operating cost and allow a large increase in capacity of the line at times of congestion and in the future; this is especially important even at the present time in the Elkhorn Tunnel, which is single track and in which, because of ventilating conditions, steam locomotives limit the speed.

Annual Convention of the National Electric Light Association

The 36th convention was held at the Medinah Temple, Chicago, June 3 to 6, and as usual there were both general and section meetings, the latter including the technical and hydro-electric, commercial and accounting sections. In this way as many as three meetings were held simultaneously. To provide for this, a large tent had been erected at the rear of the building to accommodate some of the section meetings. A fairly large exhibit of electrical apparatus was arranged in the basement. While the attendance was large, many of the meetings were of comparatively small interest owing to the lack of discussion. It is true that the list of papers did not include much of special novelty or importance, but it seemed surprising that so many engineers and others connected with the electrical industry could remain silent and inert, allowing papers and reports to pass in succession without a word of comment or criticism or any expression of personal experience or opinion. The president's address foreshadowed some changes in the management of the conventions for the future, as they are likely to become unwieldy under present arrangements.

At the opening meeting an address of welcome on behalf of the city was made by L. E. McGann, Commissioner of Public Works. The presidential address by Frank M. Tait (Dayton, O.) reviewed some of the work of the Association, and suggested that plans be considered for increasing its revenue. He suggested also that the technical and the hydro-electric and power-transmission sections should be combined and developed as an auxiliary section or association, presumably in much the same way as the auxiliary associations of the American Electric Railway Association. In regard to the losses suffered by electric-light and power companies during the recent floods, he thought it would be of interest to see what attitude will be taken by public service commissions as to the financial requirements of companies which have to practically rebuild their plants. The income from ordinary rates is not sufficient to provide for such great expenditures, and he thought the companies should be allowed to charge these expenses to capital account. This address was referred to a committee to consider its suggestions.

The report of the Committee on Organization showed a present membership of 12,142. The report of the Secretary (T. C. Martin) showed that the annual expenditures include about $50,000 for publication and $20,000 for convention expenses, leaving only about $30,000 for headquarters expenses and general work. Among its various publications the association has issued no less than 85,000 copies of its pamphlet on "Resuscitation from Shock," besides which large editions have been issued by individual companies. The Pennsylvania R.R., for instance, printed 20,000 copies for distribution among its employees. Mr. Martin presented also (by title) his annual report as chairman of the Committee on Progress, reviewing the developments in various lines of electrical work during the past year. This was in two parts, one being general and the other relating particularly to technical developments. The report of the Insurance Expert (W. H. Blood) stated that reductions in insurance rates are progressing, owing in part to the improved record from the lighting companies in regard to fire losses, while the insurance companies are making fewer claims for "faulty wiring" as the cause of fires.

A paper by Paul Lupke (Trenton, N. J.) is a regular feature of the conventions, and this year his paper, entitled "Anticipation," dealt with the education and training of beginners for and in the electrical industry. A brief report as to the work of conducting the "Question Box" department was read by S. A. Sewall, Assistant Secretary. All the above matters were disposed of at the first session.

The election of officers was held at the closing session; and under an amendment to the constitution this provided for four vice-presidents instead of two. The President is Joseph B. McCall, President of the Philadelphia Electric Co.; and T. C. Martin (New York) was reëlected Secretary.

Lamps

The striking feature in the incandescent-lamp industry, as shown by the report of the Committee on Lamps, presented by Frank W. Smith (Boston), is the rapid decline of the carbon lamp and the rapid increase of the tungsten lamp. Of the total number of lamps sold in 1912, the tungsten, gem and carbon lamps represented 39.94, 33.59 and 25.47% respectively, with tantalum for the remaining 1%. In 1907, the figures were 0.10% for tungsten, 5.88% for gem, 93.27% for carbon and 0.75% for tantalum. As compared with 1911, the carbon lamp had declined 50% in one year. Norman Macbeth (N. Y. City) remarked that the tungsten lamps are usually of higher candlepower than the carbon lamps, so that if the comparison was on the basis of light output (instead of number) the tungsten lamps would represent probably 60 to 75% of the total.

A paper on "New Developments in Incandescent Lamps," by J. E. Randall (Cleveland), stated that the most striking development is the use of wire filament wound in a helical coil, which allows a great length of filament to be put into small compass without appreciable leakage between adjacent turns. This makes it possible to construct lamps to focus closely, as for street-car and automobile headlights, etc. Another improvement is the use of certain chemicals in the lamp bulb to prevent the formation of the black deposit which so generally reduces the effective life of lamps having large filaments.

A paper on "The Flame Carbon Arc Lamp," by W. A. Darrah (Pittsburgh), dealt mainly with the design and construction details, including the regulation to insure a steady light. In a paper on "The Relation of the Incandescent Lamp to Lighting Service," by M. D. Cooper and R. E. Campbell (Cleveland), attention was called to the voltage drop in the consumer's house or plant, resulting in unsatisfactory service, which is usually attributed to the central station company, although really the company is not responsible. The average interior drop is about two volts. The remedy is in proper voltage selection of incandescent lamps and electric heating and cooking appliances. In the discussion it was pointed out that architects should be more fully informed as to the conditions of proper wiring installations.

Electrical Measurements and Meters

The brief report of the Committee on Measurements was presented by Dr. Steinmetz, in the absence of Dr. Kennelly, chairman of the committee. It predicted the abandonment of the "horsepower" as an uncertain unit, and referred to the proposed adoption of the myriawatt as a unit of power. While this is not in itself preferable to the kilowatt as such a unit, it has the advantage of being a self-explanatory decimal multiple of the watt (10,000), while it happens to be very nearly the same as the "boiler horsepower." The British proposal to adopt the term "Kelvin" in place of "kilowatt-hour" was deprecated, since it is not a self-explanatory term, while the term "watt-hour" would still have to be retained as the unit.

The Committee on Meters submitted a lengthy report dealing with meters and metering. Question has been raised as to the accuracy of watt-hour meters in measuring rapidly fluctuating loads, such as flashing signs and welding machines, but the committee considers that there is no inaccuracy of the meter under such conditions. Three forms of demand meters were described, but Mr. Parker (Rochester, N. Y.) considered that more attention should have been given to this type of instrument, owing to its importance at this time and to the limitations of existing devices. F. C. Vaughen (Schenectady) agreed with this position, but explained the difficulties which the manufacturer encounters in producing an improved design.

Electrical Apparatus

The Committee on Electrical Apparatus reviewed a number of developments in apparatus for central-station work, and called attention to the tendency to higher speeds and larger units in rotative apparatus. Turbo-generators are now made as large as 25,000 kw. and with speeds running from 3600 r.p.m. for 5000 kw. units to 1500 r.p.m. for 20,000 kw. units, while in rotary converters the commutator speed for 60-cycle machines has been made higher than 5000 ft. per min. as compared with 3000 to 4000 ft. in 25-cycle machines. There is a tendency to use direct-coupled exciters on waterwheel generators, and even on turbo-generator units. This may be found desirable from economy and simplicity, but where only few generating units are installed other sources for reserve excitation are preferable. Progress has been made in the development of 60-cycle rotaries in sizes of 1000 kw. and over for use in large direct-current lighting systems. Attention is called also to a new

form of motor converter for the conversion of alternating to direct current, which is in general use abroad.

A paper on "Switchboard Instruments," by Paul MacGahan (Pittsburgh) dealt with alternating-current and direct-current indicating instruments, and one by E. G. Reed (Pittsburgh) dealt with "Development in Distributing Transformers." The recent improvements have been in the materials and methods of winding and insulating the coils, but further improvements are more likely to relate to the magnetic circuit than to the current-carrying circuit. The report of the Committee on Grounding Secondaries stated that the rules as revised provide that grounding is required in secondary circuits up to 150 volts and is optional for circuits of higher voltage. It was stated also that connecting secondary alternating-current systems to water pipes does not tend to cause electrolysis. A paper by A. S. Hibbard (New York) dealt with the use of telephone communication between the central station and various exchanges and other points as a means of adapting the facilities of the plant to the varying conditions of load. It described in detail the systems employed by the electric generating companies of New York and Chicago.

Lightning Arresters

The Committee on Electrical Apparatus referred to the material improvements in electrolytic arresters. Disconnecting switches are recommended for use with arresters of this type, and a combined fuse and disconnecting switch now being designed will be a material improvement over present apparatus. A short paper on "The Conditions of Lightning Protection" by E. E. F. Creighton (Schenectady, N. Y.), reviewed some of the different types of arresters and the difficulties encountered in affording protection. The conditions are much worse on the lines than at stations, and while transmission lines are inadequately protected, the development of apparatus for protection on the lines is not progressing as it should. A paper on "Developments in Protective Apparatus," by J. N. Mahoney (Pittsburgh) dealt with improvements in oil circuit-breakers, carbon circuit-breakers and lightning arresters which have been brought about by the high voltages, large capacities and great lengths of lines now becoming common. Arresters of the electrolytic type are now available up to 165,000 volts, which is the highest voltage adopted commercially.

Transmission and Line Construction

A paper on "Transmission Line Construction" by R. D. Coombs (New York), related mainly to pole and tower supports. It deprecated the tendency to make poles and towers of excessive strength to provide for carrying a large proportion of broken wires, when the attachments of these wires would not stand any considerable part of such a load. A paper by A. O. Austin (New York) discussed factors affecting reliability in the suspension type of insulator now so largely employed, while another by H. H. Rudd (Pittsburgh), discussed the design of transformers for transmission lines and suggested the standardizing of certain features. Dr. Steinmetz compared the direct-current and polyphase systems of transmission and indicated the marked superiority of the alternating current.

The report of the Committee on Underground Construction dealt with high-tension transmission cables and their installation. This was accompanied by specifications for cables. The report of the Committee on Distributing Lines pointed out that voltages as high as 100,000 or 150,000 are being used for transmission and that a number of distributing systems in rural districts operate at voltages as high as 22,000; this last is about the limit (except in the case of large consumers) owing to the high transformer cost. In the congested business centers of large cities direct-current can sometimes be used to advantage.

The report of the Joint Committee on Overhead Line Construction (which represents also the American Institute of Electrical Engineers, the American Electric Railway Association, the Association of Railway Telegraph Superintendents, and the American Railway Engineering Association) presented specifications for overhead crossings of electric-light and power lines. It suggested that specifications should be prepared for the construction of constant-potential lines of over 5000 volts, which are constructed parallel with or close to telephone and telegraph lines. A paper on "Poles and Pole Preservation," by R. A. Griffin (Chicago) referred to the increasing consumption of poles and recommended (1) the conservation of the forests; (2) the more economical use of the present supply of timber, and (3) the preservation treatment of poles. The open-tank system of treatment is effective if the oil is heated and then cooled (or the poles transferred to a tank of cold oil) so that the partial vacuum thus caused will assist in the penetration. This penetration will be much greater than by simply dipping or brushing the poles. The proportion of poles treated by the closed-retort system is relatively small.

Applications of Electricity

The papers and reports were by no means limited to the question of lighting, and one group of subjects related to the development of central-station business in supplying current for power for various purposes. A paper by E. P. Dillon (Pittsburgh) suggested the desirability of city and interurban electric railways as customers for central stations, and instanced the conditions in Chicago, Cleveland, New York and other cities. The electric vehicle was suggested by E. E. Witherby (Chicago), as a great opportunity, and it was shown that some electric companies act as local agents for manufacturers of these vehicles. The application of central-station current for lighting and power in coal mines was outlined by W. A. Thomas (Pittsburgh).

The report of the Committee on Steam Heating discussed the matter of isolated plants in large cities, furnishing both heat and light, as compared with plants furnishing heat only and taking lighting current from central stations. It was stated that in one case in Chicago it has been found economical to dispense with the dynamos and use the boiler plant simply for heating. The report of the Committee on Refrigeration suggested the advantages of developing central-station current for the operation of refrigerating and ice-making plants.

Another possible and promising line of business development is electric distribution from central-station plants to small towns (less than 5000), this including the absorption of existing local (and often unprofitable) plants. This was discussed in a paper by J. E. Kearns (Schenectady, N. Y.). As a further extension of this

idea, several reports dealt with the development of the use of electricity in rural districts and on the farm. The former includes such industrial work as the operation of excavators, gravel washing and screening plants, quarries, clay-working industries, pumping plants, etc.

Machinery

The report of the Committee on Prime Movers reviewed the developments in water, steam and gas operated machinery. As to the first, it mentioned sundry improved auxiliary devices, and recommended investigation of the subject of continuous measurement of stream flow and wheel consumption in plants under operation. As to the second, it referred particularly to the Ferranti high-superheat steam turbine, the principle of which is to maintain the steam in a perfectly gaseous state through the turbine. The steam is re-superheated between the first and second stages, and then passed through a regenerator between the exhaust and the condenser, so that the excess heat is reclaimed. A machine of 5000 hp. has been built. As to gas power, the report states that there has been no important development. The gas turbine has not been made a success as yet, and there has been noticeable decrease in the use of engines operating on illuminating gas. One of the devices mentioned by the committee was a new form of thrust bearing, used on the hydraulic turbines of the hydro-electric plants at Keokuk, Iowa., and McCall's Ferry, Penn., and in the steam turbines of the U. S. collier "Neptune." This device was described in a paper by Albert Kingsbury (Pittsburgh) the inventor.

The report of the Committee on Operation of Water Power Systems was of a general character, outlining the operating features in relation to the generating plant and the electrical apparatus under normal and emergency conditions. It was stated that practically no hydro-electric development with the capacity of the apparatus above the rated capacity at minimum stream-flow is attempted without the provision of a steam-power station on the system. This may serve (1) as an auxiliary station during low-water periods; (2) as a reserve in case of interruptions; (3) as a regulating station to take care of variations in the load when the hydro-electric plant is running at constant output.

Miscellaneous

The report of the Public Policy Committee, presented by Samuel Insull (Chicago) stated that the tendency of the industry is toward a regulated monopoly, as against destructive competition. As to employees, adequate compensation for their work and proper care of their welfare tend to economy and to favorable public opinion. A renewal of a former tendency to municipal ownership and operation of public utilities is considered imminent, and it was suggested that members should see that the local papers are supplied with publications relating to the companies' side of the question. A paper by E. H. Thomas (Seattle) on "The Failure of Conservation" was a general and somewhat wild attack on the government's policy of protection and conservation of national resources in the interests of the nation and the public, instead of allowing these resources to be exploited for private gain to the detriment of the public. A talk on "Resuscitation from Electric Shock," by W. C. L. Eglin (Philadelphia) threw some doubt upon the value of the pulmotor, and spoke more favorably of the Meltzer mechanical method of artificial respiration. Following this was a lecture by J. B. Douglas (Philadelphia) on "Accident Prevention in Public Utilities"; this related to the protection of such danger points as moving machinery, high-tension apparatus, etc., and to the general policy of safeguarding life and limb in industrial enterprises.

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The Piling for a Bridge was Driven Through the Cab of the Locomotive of the Pennsylvania R.R. Co., which went through a flood-weakened Big Four bridge at West Liberty, Ohio, on Mar. 25. A coffer-dam had been constructed and pumps installed when a diver found that the piling driven for a temporary bridge had pinned down the locomotive.

Six-Hundred Pounds of Dynamite Exploded in the machine packing house of the Giant Powder Co., at Giant, Calif., on May 30, killing four men and annihilating the building, leaving only an excavation 7 ft. deep to mark the site. The cause of the explosion is unknown. The last accident of a similar nature occurring at this plant was in 1907, when the nitroglycerin mixing-house was blown up.

Two Missouri Pacific Passenger Trains Collided on May 27, near Brant, Mo., killing four trainmen and injuring nine others and six passengers. The "St. Louis Times" states that the accident was caused by conflicting orders concerning the point where the trains, Nos. 11 and 12, should meet, and a mistake of the block signal man in permitting the two trains on the same block. The train dispatcher, who issued the orders, accepts all responsibility for the wreck.

The Tunis Mono-Rail Railway, which has been in operation for three years past in Pelham Park, in the northern part of New York City, is soon to be rebuilt as a regular standard-gage trolley line. It is claimed that the road has been successful mechanically, but it connects at the southern end with an ordinary trolley railway, necessitating a change of cars for a short ride. The Tunis monorail line installed last winter in the underground tunnel connecting the Capitol at Washington with the Senate office building, is also to be abandoned. The reason for the abandonment is the noise made by the car wheels rolling on the rail, augmented by the echo from the tunnel walls.

PERSONALS

Dr. Alexander MacAlister has resigned as President of Drexel Institute, Philadelphia, Penn.

Mr. Elson Hale, formerly City Engineer of Pine Bluff, Ark., has been appointed City Engineer of Little Rock, Ark.

Mr. R. T. Martin, formerly Assistant City Engineer of Tampa, Fla., has been appointed City Engineer, succeeding Mr. F. T. Warren, resiged.

Mr. E. A. Clark, M. Am. Soc. C. E., is Chief Engineer of the Engineering Construction Co., recently organized, with offices at 106 North La Salle St., Chicago, Ill.

Mr. J. Edgar Johnson, formerly Eastern Representative at New York City of the P. & M. Co., Chicago, Ill., has been appointed Division Engineer of the Pere Marquette R.R., at Saginaw, Mich.

Prof. V. I. Smart, of the department of railway engineering, McGill University, Montreal, Que., has resigned to accept the position of General Manager of the General Railway Signal Co. of Canada.

Mr. Peter P. Smith, a lawyer of Brooklyn, N. Y., has been appointed a Special Deputy Attorney of New York State to prosecute contractors for alleged fraud in connection with recent state-highway work.

Col. William Crawford Gorgas, Assistant Surgeon General, U. S. A., Chief Sanitary Officer of the Panama Canal Zone, was awarded the honorary degree of Doctor of Science at Columbia University on June 4.

Mr. F. G. Glover has been appointed Electrical Engineer of the Chicago, Rock Island & Pacific Ry., with headquarters at Chicago, Ill., succeeding Mr. F. E. Hutchinson, resigned, as noted in our issue of May 29.

Mr. R. B. Elsworth, formerly Assistant Signal Engineer of the New York Central & Hudson River R.R., at Albany, N. Y., has been promoted to be Engineer of Maintenance of Signals, succeeding Mr. J. M. FitzGerald.

Mr. Reginald J. S. Pigott, Jun. Am. Soc. M. E., has resigned as Assistant Professor of steam engineering, Columbia University, New York City, to accept a position with the Interborough Rapid Transit Co., New York City.

Mr. F. D. Batchellor, formerly Assistant to the General Superintendent of the Baltimore & Ohio Southwestern R.R., has been appointed Assistant Superintendent of the Cincinnati, Hamilton & Dayton Ry., at Dayton, Ohio.

Mr. E. D. Sabine, Resident Engineer of the Grand Central Terminal, New York Central & Hudson River R.R., New York City, has been promoted to be Terminal Engineer, succeeding Mr. W. L. Morse, M. Am. Soc. C. E., resigned, as noted elsewhere.

Mr. F. H. Judd, formerly Assistant Engineer of Buildings, New York Central & Hudson River R.R., New York City, has been promoted to be Resident Engineer, Grand Central Terminal, succeeding Mr. E. D. Sabine, promoted as noted elsewhere.

Mr. John I. Miller has been appointed Superintendent of Public Works of Ohio at a salary of $4000 per annum. Mr. Miller was nominated by ex-Governor Harmon, but the confirmation of his appointment was held up during the winter by Governor Cox, who has now reappointed him.

Mr. George B. Preston, M. Am. Soc. C. E., formerly Engineer, Westinghouse, Church, Kerr & Co., New York City, has been appointed Assistant Professor of steam engineering, Columbia University, succeeding Mr. Reginald J. S. Pigott, resigned, as noted elsewhere.

Mr. R. E. Hore, M. Am. Inst. M. E., Geologist of the Michigan Geological Survey and Instructor at the Michigan College of Mines, has been appointed Editor of the "Canadian Mining Journal," with headquarters at Toronto, Ont. Mr. Hore is a graduate of the University of Toronto.

Mr. Gustav Rasmus, Consulting Mechanical Engineer, of New York City, has retired from engineering practice to become associated with Messrs. Lawrence I. Gallagher and William F. Nickel, formerly Patent Examiners, U. S. Patent Office, as Patent Attorneys, 2 Rector St., New York City.

Mr. E. G. Chenoweth, former Assistant Superintendent of the car department, has been appointed Mechanical Engineer of the Chicago, Rock Island & Pacific Ry., in charge of car design, succeeding to a part of the duties of Mr. C. A. Seley, Mechanical Engineer, resigned, as noted in our issue of Apr. 17.

Mr. Charles Yoder, formerly Assistant Engineer of the Lake Shore & Michigan Southern Ry., at Cleveland, Ohio, has been promoted to be Assistant Engineer of Track of the Lake Shore & Michigan Southern Ry., and the Dunkirk, Allegheny Valley & Pittsburgh R.R. His headquarters will remain at Cleveland.

Mr. E. W. Scheer, formerly Assistant to the General Superintendent of the Baltimore & Ohio Southwestern R.R., has been appointed Superintendent of the Illinois division, at Flora, Ill., succeeding Mr. F. B. Mitchell, appointed Superintendent of the Toledo division of the Cincinnati, Hamilton & Dayton Ry., at Dayton, Ohio.

Mr. W. L. Morse, M. Am. Soc. C. E., Terminal Engineer, New York Central & Hudson River R.R., in charge of the Grand Central Terminal reconstruction, New York City, has been appointed Chief Engineer of the Jacksonville Terminal Co., a new organization of the railways entering Jacksonville, Fla., for the purpose of constructing a union terminal.

Mr. August E. Christhilf, formerly Chief Engineer of the commissioners for opening streets, of Baltimore, Md., has been appointed Assistant Superintendent of Public Works, of Atlanta, Ga., at a salary of $3000 per annum. After leaving his position with the city of Baltimore, Mr. Christhilf was Chief Engineer of the F. E. Schneider Paving Co., of that city.

Mr. G. S. Goodwin, recently Assistant Mechanical Engineer of the Chicago, Rock Island & Pacific Ry., at Silvis, Ill., has been promoted to be Mechanical Engineer in charge of locomotive design, succeeding to a part of the duties of Mr. C. A. Seley, Mechanical Engineer, resigned, as noted in our issue of Apr. 17. Mr. Goodwin's headquarters will be in Chicago, Ill.

Mr. L. Jutton, formerly General Inspector of Bridges of the Chicago & Northwestern Ry., at Chicago, Ill., has been promoted to be Division Engineer, with headquarters at Madison, Wis. Mr. Jutton graduated from the University of Illinois in 1902. He entered the bridge department of the Chicago & Northwestern Ry. in the fall of 1903 as a structural draftsman.

Mr. J. E. Willoughby, M. Am. Soc. C. E., has resigned as Chief Engineer of the Caribbean Construction Co. and the Compagnie Nationale des Chemins de Fer d'Haiti, at St. Marc, Haiti, to become Assistant Chief Engineer of the Atlantic Coast Line R.R., at Wilmington, N. C. Until about a year ago he was Engineer of Construction of the Louisville & Nashville R.R.

Prof. J. P. Jackson, F. Am. Inst. E. E., Dean of the school of engineering, Pennsylvania State College, has been appointed Commissioner of the newly created Department of Labor and Industry of Pennsylvania. The new department will take over the duties and powers of the present Department of Factory Inspection. There will be three bureaus under the new department—inspection, statistics and arbitration.

Prof. W. K. Hatt, M. Am. Soc. C. E., head of the school of civil engineering at Purdue University, has been appointed Chairman of a commission of engineers to make a design for a new bridge over the Wabash River at Lafayette, Ind., replacing one washed out by the recent floods. The new bridge is estimated to cost $250,000. The other members of the commission are: Mr. Everett Vawter, a civil engineer of Lafayette, and Prof. Albert Smith, of Purdue University.

Mr. John A. Ferguson, formerly Assistant Engineer of reinforced-concrete construction, Bureau of Construction, Department of Public Works, Pittsburgh, Penn., in charge of the design of and specifications for reinforced-concrete bridges, has been transferred to the Bureau of Building Inspection, Department of Public Safety, as Engineer in charge of the inspection of the engineering features of buildings and their acceptance or rejection by the bureau.

Mr. C. H. Baker, formerly Chief Engineer of the Hoosac Tunnel power station of the Boston & Maine R.R., and the Berkshire Street Ry., has been appointed Mechanical Engineer of the Public Service Electric Co., Newark, N. J. Mr. Baker graduated from Lawrence Scientific School, Harvard University, in 1902, and has served on the engineering staffs of Westinghouse, Church, Kerr & Co., the Brooklyn Rapid Transit Co., and as Assistant Chief Engineer of the Cos Cob power plant of the electric division of the New York, New Haven & Hartford R.R.

Mr. Robert G. Dieck, M. Am. Soc. C. E., Consulting Engineer, of Portland, Ore., was elected a Commissioner of Portland, for a term of four years, commencing July 1, at the recent municipal election under the new commission plan charter. Mr. Dieck was born in Philadelphia, Penn., Dec. 24, 1875. He was educated in the public schools of Philadelphia and at the University of Pennsylvania, where he graduated in civil engineering in 1896. For three years he was employed with the Board of Highway Supervisors of Philadelphia upon highway and underground improvements. After a year in the engineering department of the Bureau of Filtration of Philadelphia, Mr. Dieck accepted an appointment under the United States Bureau of Insular Affairs as Provincial Supervisor, Philippine Islands. In 1902, he was appointed Superintendent of Water Supply and Sewers of Manila, P. I., where he was in charge of the design and construction of a storm-water drainage system, an improved distribution system for water, and other important work. In 1905 he was appointed City Engineer of Manila in charge of all municipal improvements. In conjunction with the Director of Health of the Philippine Islands, Dr. Victor G. Heiser, he drew the new building and sanitary codes for the city. He was also one of the five members of the Municipal Board of Manila, which consisted of the Mayor and four members with much the same powers as are given to the Commissioners of Portland under the new charter. Since 1907, Mr. Dieck has been in private practice as a consulting civil engineer at Portland. In 1910 and '11 he served as Chairman of a committee of three to draft a new plumbing code for the city.

OBITUARY

William F. Brusher, one of the founders of the Standard Gas Engine Co., of San Francisco and Oakland, Calif., died at his home in Oakland, May 24. He is survived by a widow and five children.

George L. Hall, President of the National Railways Material Co., and Secretary of the Knickerbocker Valve Co., died at the Presbyterian Hospital, New York City, June 1. He graduated from Princeton University in 1889 and for many years was a practicing civil engineer.

George B. Francis, M. Am. Soc. C. E., Consulting Engineer, New York City, died June 9, at his home in New York, of hemorrhage of the brain. He was also a member of the Canadian Society of Civil Engineers, and the Institution of Civil Engineers of Great Britain. A biographical sketch will appear in a later issue.

Curtis H. Peters, Mechanical Engineer for Winston & Co., General Contractors, was killed on June 9, when his motor car was run into and wrecked by an express train on the Ulster & Delaware R.R. at Browns Station, N. Y. Mr. Peters was on an inspection tour of the Catskill Aqueduct and Ashokan Reservoir work, for which Winston & Co. have large contracts.

John Kingsbury Dean, a mechanical engineer and salesman of the Dean Bros. Steam Pump Works, Indianapolis, Ind., died at his home in Indianapolis, June 1, aged 44 years. He leaves four brothers, Charles G. Dean, of Milwaukee, Wis., Stuart Dean, Superintendent of the Dean Bros. Steam Pump Works, Douglas Dean, of Chicago, Ill., and Ward Hunt Dean, of Indianapolis.

Hartwell Bishop, a civil engineer of San Francisco, Calif., and son of Joseph Bucklin Bishop, Secretary of the Isthmian Canal Commission, died June 4, at the Peter Bent Brigham Hospital, Boston, Mass. He was 33 years old and a graduate of Harvard University, class of 1903. Subsequently he took a post-graduate course in civil engineering at Columbia University and was for a time in tunnel work in New York City. He went to San Francisco after the earthquake, and for seven years was employed by the United Railroads of San Francisco on construction work. He had recently come East on a vacation. Mr. Bishop is survived by his parents, a brother Farnham Bishop, a sister, and a widow to whom he had been married but a year and a half.

Joseph Lewis Stephenson, a pioneer civil engineer of Salt Lake City, Utah, died at his home in that city May 31. He was born in Uppersville, Va., Apr. 13, 1834, and graduated from the Virginia Military Institute in 1854. During the Civil War he served four years in the Confederate Army. At the close of the war he resumed his occupation as a civil engineer and served with the engineering staffs of several pioneer Western railways ending his railway experience with the Denver & Rio Grande and the Rio Grande Western. In the early '80's he took up irrigation work in Idaho and superintended the construction of many miles of ditches and the building of several dams. He was also engaged at one time in municipal work in Denver, Colo. For the past 17 years he had held a position in the office of the Surveyor-General of Utah.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 11-13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

OHIO ELECTRIC LIGHT ASSOCIATION.
June 15-18. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
June 16. Semi-annual meeting at Atlantic City, N. J. Secy., Jos. A. Andreucetti, Room 411, C. & N. W. Ter. Sta., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

TRAIN DISPATCHERS' ASSOCIATION OF AMERICA.
June 17-19. Annual meeting at Los Angeles, Calif. Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 17-20. Annual convention at Ottawa, Ont. Secy., Charles Warren Hunt, 220 W. 57th St., New York City.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 20-21. Annual convention at Seattle, Wash. Secy., Jesse A. Jackson, City Hall, Seattle, Wash.

AMERICAN INSTITUTE OF ELECTRICAL ENGINERS.
June 23-26. Annual convention at Cooperstown, N. Y. Secy., F. L. Hutchinson, 33 W. 39th St., New York City.

AMERICAN WATER-WORKS ASSOCIATION.
June 23-28. Annual meeting at Minneapolis, Minn. Secy., J. M. Diven, Troy, N. Y.

PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES.
June 23-28. Congress at London, England. Secy., W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminister, London, S. W.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 24-26. Annual meeting at Minneapolis, Minn. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 24-28. Annual convention at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

CANADIAN ELECTRICAL ASSOCIATION.
June 25-27. Annual convention at Toronto, Ont. Secy., T. S. Young 220 King St. West, Toronto, Ont.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 25-28. Semi-annual meeting at Boston, Mass. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 17-19. Annual summer meeting at Buffalo, N. Y. Secy., E. A. Scott, 29 W. 39th St., New York City.

INTERNATIONAL GEOLOGICAL CONGRESS.
Aug. 7-14. Twelfth annual session at Toronto, Ont. General Secy., R. W. Brock, Director of Geological Survey of Canada, Ottawa, Ont.

THE TRAVELING ENGINEERS' ASSOCIATION.
Aug. 12-16. Annual convention at Chicago, Ill. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

Iron and Steel Institute—The autumn meeting will be held in Brussels, Sept. 1-4.

American Road Congress—The annual meeting will be held in Detroit, Sept. 29-Oct. 5.

American Road Builders' Association—The annual convention will be held in Philadelphia, Dec. 9-12, at the First Regiment Armory.

Western Railway Club—At the meeting held in Chicago on May 27 officers were elected as follows: President, Henry LaRue (C., R. I. & P. Ry.), Chicago; Vice-Presidents, W. B. Hall (Union Railway Equipment Co.) and E. W. Pratt (C. & N. W. Ry.). The Secretary is J. W. Taylor, Old Colony Building, Chicago.

International Railway Fuel Association—At the Chicago convention on May 24, the following officers were elected for the ensuing year: President, Robert Collett, of Springfield, Ill.; Vice-Presidents, A. C. Buell, of Omaha, Neb., and D. R. Sebastian, of Chicago, Ill.; Secretary-Treasurer, C. Y. Hall, of Chicago, Ill.

Natural Gas Association of America—At the annual convention held in Cleveland, Ohio, May 22, the following officers were elected for the ensuing year: President, E. L. Brundrett, of Kansas City, Mo.; Vice-President, F. L. Chase, of Columbus, Ohio; Secretary-Treasurer, T. C. Jones, of Delaware, Ohio. The next convention will be held in St. Louis, Mo., in May, 1914.

American Society of Civil Engineers—For the 45th annual convention to be held in Ottawa, Can., June 17-20, the following program has been announced: June 17, at 3 p.m., there will be a reception by the Premier, the Right Honorable R. L. Borden, and the Mayor of Ottawa, at the Chateau Laurier. At 9 p.m. the president and officers of the society will hold an informal reception at the Chateau Laurier. On June 18, at 10 a.m., the first session will be called to order, and the president will deliver the annual address, after which the business meeting will convene. In the afternoon the members and guests are invited to attend a garden party at the residence of T. C. Keefer, Past President, Am. Soc. C. E.; and in the evening there will be a lecture on Canadian Engineering subjects at the Chateau Laurier. The program for the morning of June 19 will be announced at the business meeting. In the afternoon there will be a motor drive through the city. The tea, which was to have been given at the residence of Sir Sanford Flemming, will be omitted. In the evening the Ottawa branch of the Canadian Society of Civil Engineers will tender a reception at the Chateau Laurier.

American Institute of Electrical Engineers—The thirtieth annual convention will be held in Cooperstown, N. Y., June 23-27. The following papers have been announced:

(1) "A Suggestion for the Engineering Profession," by William McClellan; (2) "Test of an Artificial Aërial Telephone Line at a Frequency of 750 Cycles per Second," A. E. Kennelly and F. W. Lieberknecht; (3) "The Adaptation of Automatic Methods to Long-Distance Telephone Toll Switching," H. M. Friendly and A. E. Burns; (4) "Electrolytic Corrosion of Iron in Soils," Burton McCollum and K. H. Logan; (5) "The National Association of Corporation Schools," F. C. Henderschott; (6) "Vocational Education in Philadelphia and Vicinity," A. J. Rowland; (7) "Vocational Training in the Far West," Robert Sibley; (8) "The Pennsylvania Railroad Company Apprentice Schools," John Price Jackson and J. W. L. Hale; (9) "Suggested Specifications for Testing High-Tension Insulators," J. A. Sandford, Jr., and F. W. Peek, Jr.; (10) "Constant Voltage Transmission," H. B. Dwight; (11) "Theory of the Non-Elastic and Elastic Catenary as Applied to Transmission Lines," C. A. Pierce, F. J. Adams and G. I. Gilchrist; (12) "The Behavior of Synchronous Motors during Starting," F. D. Newbury; (13) "Commutating Pole Saturation in Direct-Current Machines," H. E. Stokes; (14) "The Industrial Use of Synchronous Motors on Central Station Lines," J. C. Parker; (15) "Electrical Requirements of Certain Machines in the Rubber Industry," C. A. Kelsey; (16) "Standardization of Method for Determining and Comparing Power Costs in Steam Plants," H. G. Stott and W. S. Gorsuch; (17) "Automatic Substations," H. R. Summerhayes; (18) "Converting Substations for Basements and Sub-Basements," B. G. Jamieson; (19) "Operation of Frequency Changers," N. E. Funk; (20) "The Electric Strength of Air," J. B. Whitehead and T. T. Fitch; (21) "The Positive and the Negative Corona," W. W. Strong; (22) "Law of Corona and the Dielectric Strength of Air," F. W. Peek, Jr.; (23) "An Oscillographic Study of Corona," Edwin Bennett.

ENGINEERING LITERATURE

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REVIEWS AND NOTES

Paving Specifications and Construction

Reviewed by EDWIN A. FISHER*

SPECIFICATIONS FOR STREET ROADWAY PAVEMENTS, With Instruction on Street Paving Work—By S. Whinery, M. Am. Soc. C. E. Second edition, enlarged and entirely reset. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. x + 116; illustrated. $1, net.

ASPHALT CONSTRUCTION FOR PAVEMENTS AND HIGHWAYS—A Pocket-Book for Engineers, Contractors and Inspectors. By Clifford Richardson, M. Am. Soc. C. E. New York and London: McGraw-Hill Book Co. Leather; 4x7 in.; pp. ix + 155. $2, net.

The standardizing of paving specifications is receiving more general attention than ever before. The value of co-operation by municipalities is also being more appreciated. The reviewer agrees with Mr. Whinery that, notwithstanding the activity of the various societies in presenting standards in pavement specifications [since the first edition of this work appeared.—Ed.] there is still room for individual effort; and the reviewer would add, especially by one so thoroughly equipped as the author by long and successful experience as chief engineer and manager of a large paving company, whose careful, painstaking work the reviewer remembers with much pleasure. The author also has had a large experience as consulting engineer for a number of the larger cities in the country. His careful use of language makes the work of great value to the engineer as a model of clear and concise expression.

Besides revising his earlier specifications for various types of pavements (reviewed by the present writer in these pages on Aug. 15, 1907) the author has added specifications "for two comparatively new kinds of roadway pavement that have merited attention, and for concrete sidewalk and concrete combined curb and gutter." He has also added some twenty-five pages of "Instructions to Inspectors," both general and relating specifically to the various types of construction covered by his specifications.

In his introductory pages the author treats of the subject of contracts and contractors with the extreme candor and fairness expected by one of his training and experience. He deserves special commendation for his very clear and definite statements regarding the responsibility of the contractor, the engineer and the municipality.

While the reviewer agrees with the author in his statement (page 11) that it is both unwise and illegal to provide that the decisions of the engineer shall in all cases be final and conclusive, he is of the opinion that the engineer can and should act in an absolutely impartial manner, regardless of the fact that his salary is paid by the municipality. The reviewer commends the Introduction as a whole, and if the book contained nothing else, its publication would be fully justified.

Section 23, on incidental work at the contractor's expense, is in the interest of a clear understanding of what is required. Section 24, relating to extra work for which the contractor is entitled to payment, is excellent, although in the reviewer's practice it is amplified as follows:

In case the engineer deems it impracticable to estimate said extra work, as aforesaid, the contractor shall present an itemized account of the labor and material used in said work, which account must be verified by the inspector on the work; and said contractor shall be paid the actual cost, together with 15% of his payroll additional for supervision and use of tools. Claims for extra work must be presented to the engineer on or before the tenth day of the month following in which said extra work was done.

The guaranty clause, Section 25, is especially clear and fair, both to the municipality and the contractor.

The reviewer agrees with the author now, as he did in 1907 in a review of an earlier edition of this work, that the practice of laying pavement surfaces, particularly those of asphalt, upon a foundation of old stone blocks reset with the joints unfilled with mortar, is all wrong and should never be resorted to. It is a source of satisfaction that in the reviewer's experience he has never been obliiged to use this form of construction.

The reviewer also agrees with the note on page 24, to the effect that old stone block and cobble-stone pavements that have become solidified in place by long travel, make a good foundation for asphalt or other pavements, provided they can be utilized without taking up or disturbing the old pavement. The objection to this method of construction is the fact that such pavements cannot be as well repaired in case of cuts, as those with a concrete foundation.

The author is right in holding that the proportions of cement, sand and broken stone should be left blank in a general specification. He believes it is undesirable to have different specifications used by the same contractor on the same job.

In view of the increasing weight of motor trucks the reviewer believes that in no case should a concrete foundation be laid less than 6 in. in thickness; and in important thoroughfares this thickness should probably be increased to at least 9 in.

The reviewer agrees with the author in his specifications for 5¼-in. depth for granite blocks. He believes that there is no good reason for making blocks deeper than this on any street. He also believes that the extra cost of dressing blocks so that the joints will not exceed ⅜ in. is fully justified.

With reference to filling joints, the reviewer has never seen the necessity of laying blocks near the curbstone parallel with the curbs. He believes that it is best to have as few breaks in the pavement as possible, and would lay the blocks continuous from curb to curb. He also never has seen the necessity of expansion joints across the street.

The reviewer does not agree with the author in his specifications for brick pavements. He thinks it is extremely desirable that the size of brick be standard, and fully agrees with the specifications of the American Society of Municipal Improvements and the Association for Standardizing Paving Specifications in providing for a standard size. He also believes that the average loss in the new rattler should not be made as low as 18%. The new rattler is between 4 and 5 points more severe than the old.

The reviewer disagrees emphatically with Section 90, with reference to the longitudinal gutter course, and to filling the six contiguous courses running across the street in a length of 50 ft. with bituminous cement while the remainder of the pavement is filled with cement grout. In his experience he has become satisfied that the cross expansion joints are not required, and that expansion joints at the curb should be made by one joint at the curb and not by a number of joints in courses of brick, laid parallel with the curb.

The specifications relative to paving where railway tracks exist should be amplified. A pavement foundation under the rail of the same depth as that under the remaining part of the pavement is entirely insufficient for the heavy cars now in use by the street surface railways. The reviewer's experience is that the concrete for a distance of about 18 in. outside the outside rails should be not less than 12 in. in thickness.

*City Engineer, Rochester, N. Y.

The specifications for asphalt pavement reflects the experience and study of the author in the branch of the work in which he is especially well qualified.

The specifications for combined curb and gutter are excellent, and the reviewer agrees with the author in the note on page 84 relative to hydraulic-concrete sidewalks, that while the specifications conform to the common practice in laying sidewalk in two courses, such construction is neither necessary nor desirable. In view of the opinion of the author, it is the intention of the reviewer in his practice to change his specifications to correspond to this opinion.

The section on regrading (page 88) is excellent, and one that has not generally been considered. The instructions to inspectors on street-paving work, with such changes as may be necessary to adapt them to the conditions in the different municipalities, are in every way commendable.

The book is a very valuable contribution to the literature upon the proper construction of pavements and will have much influence in standardizing, so far as local conditions permit, the specifications for this kind of work.

Mr. Richardson, in his handbook on "Asphalt Construction for Pavements and Highways," very properly emphasizes the necessity of careful attention to details in the construction of a successful asphalt pavement. He also cautions the engineer against following literally so called standard specifications which are only of general application. This action is timely, and applies as well to other kinds of work as to asphalt pavements. The author has probably had a larger experience in the construction of asphalt pavements and in a critical observation of pavements of which he has known the exact details of the material entering into them and the workmanship than any other person.

The author first deals with broken stone, the foundation and the intermediate course, which last is made to include a general review of asphaltic pavement and binders as well as asphaltic-concrete bearing surfaces. He next takes up the mineral aggregate, the filler or dust, native bitumens, fluxes and asphaltic cements. None of these chapters is long, the whole nine just outlined aggregating about fifty pages As much space is then devoted to the single chapter on "Surface Mixtures," and again as much to the last seven chapters, which treat of maintenance and repairs, the plant, work on the street, advice to engineers, contractors and inspectors, the laboratory, examinations of materials and instructions for taking various samples for examination.

Touching now upon a few points of the book, it may be mentioned, first of all, that the description of the proper quality of broken stone is concise and definite. Although the author's advocacy of a comparatively smooth surface for the concrete foundation for sheet asphalt is at variance with the usual current practice, yet the reasons given for a relatively smooth surface for a comparatively smooth surface are sound. It would seem, however, that if the concrete were somewhat rough the pavement would not be as likely to roll as if it were made as smooth as possible.

The instructions relative to binder (pages 16-22) are very clear and specific. The author devotes, very properly, a large amount of space (Chapter 5) to the grading of the sand. From the experience of the reviewer, the failures in asphalt pavements have resulted more from the use of improper sand than from any other cause.

On page 45 it is stated that the handbook is confined to the use alone of the Trinidad and Bermudez asphalts, and that many of the directions can be applied to the use of other materials. It is to be regretted that the author has not given more detailed instructions relative to the use of such other asphalts as are now in general use.

The instructions to the inspector, with the illustrations given on pages 74-77 inclusive, are valuable in making quick tests of the mixture upon the street. The advice to engineers, contractors and inspectors, and the suggestions to citizens, in Chapter 14, are worthy of very careful consideration.

The book as a whole is of great practical value, especially to the engineer in charge of a laboratory for use in connection with the inspection of asphalt pavements.

CITY OF BRIDGEPORT, CONN.: A Study of the Organization and Procedure of Each Permanent Board, Commission, Committee and Office (except those concerned with Courts, Education and Elections)—Report of Peter White, Resident Partner, at Chicago, of Haskins & Sells, C. P. A., New York City. Paper: 7x10 in.; pp. 112.

Similar studies of the organization duties and methods of the various city departments might profitably be made in every city of the country where such studies have not been undertaken—which means the vast majority of them. This study is particularly valuable because of its running comment on the general functions of the various departments and because of its "constructive suggestions" at the end of each departmental study. The various recommendations are briefly summarized in the opening pages of the report, which adds materially to its value. The study as a whole was made under the direction of a Committee on Audit, created late in 1911 to "provide a uniform system of audit and account" for all branches of the city government. It is interesting to note that the city engineer receives the highest salary ($4000) of any official of Bridgeport, and that quite recently the resignation of the director of public works and superintendent of streets were, by arrangement, put in his hands. He is, however, subject in some respects to the orders of the Commission on new paving and sewer work.

A British Book on Structural Engineering

Reviewed by LEWIS J. JOHNSON*

THEORY OF STRUCTURES—By Arthur Morley, M. I. Mech. E.; Professor of Mechanical Engineering, University College, Nottingham. New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5x9 in.; pp. xi + 574; 4 plates; 319 text figures. $2.50, net.

This work begins with the rudiments of resistance of materials and considerably more than half its space is devoted to that introductory topic. The topics therein treated are the usual ones of simple tension, compression, shear and bending, with applications to strength and stiffness of beams and columns. The last part of the book treats of the theory of frames (simple as well as indeterminate), stresses from fixed and variously placed loads, design of details of plate girder and truss bridges, theory of suspension bridges, metal arches, stability of earthwork and masonry.

Much of the introductory matter has been taken, as the author states in the preface, from his earlier work, "Strength of Materials" (Reviewed in "Eng. News," Aug. 12, 1909, p. 12, Eng. Lit. Sup.) "without great modification." The topics which appeared in "Strength of Materials" which do not reappear in "Theory of Structures" include little else than torsion, flat plates, and descriptions of testing apparatus and methods. "Theory of Structures" may, therefore, be regarded as a revised and enlarged edition of the former work, the revisions and extensions being directed solely to meet the needs of designers of roofs and bridges.

Like its predecessor, this book makes, on the whole, a distinctly favorable impression. One could wish, however, for an even clearer lining out of the great fundamental principles of statics, and assumptions of resistance of materials. The style is still conventionally didactic enough to obscure to an unnecessary extent the inferential nature of many of the statements. For example, Rankine's "Theory of Earth Pressure" is stated without making clear that it rests on something more substantial than a great name. A few lines would have made it clear why so wise a man as Rankine fathered it—to the advantage of the reader's comprehension of engineering science and his intelligent respect for Rankine.

Even in this later work Morley has not supplanted the ellipses of stress and inertia with the vastly simpler and more instructive circle of stress, suggested long since by Kulmann, and the Müller-Breslau or Mohr-Land circles of inertia. He repeats, in his cuts of columns with various end conditions, the absurdity too common in textbooks of not showing the full set of external forces in action, thus encouraging a thoughtless student with an over developed faith in authors to assume that cases do after all arise in which a body may be in equilibrium under the action of two non-coincident forces.

The treatment of structural connections and design is so thoroughly British as to be of little but suggestive value to the American student. Its phraseology in using "railbearers" for stringers, and its transformation of a weight estimate of 15,545 perfectly good pounds into an alleged equivalent of "6 t. 18c. 3q. 5 lb." are harmonious with its use of T's and small flats as main members of riveted trusswork as something that would not flourish on this side of the Atlantic. We have not checked the metamorphosis through which the 15545 was put! We may well rest content with being learned enough to be aware that t., c., and q. stand for 2240, 112 and 28 lb. units respectively!

It is a pleasure to commend in this, as in "Strength of Materials," the abundance of fully worked out numerical problems, besides an abundance of well selected problems for practice.

In a word, the work may be characterized as containing little that is new, but nevertheless an excellent treatise on

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the mathematical or theoretical aspects of structural design. When it comes to practical design, however, the American student should turn to any of several excellent modern American works for his book treatment of that subject.

The Steel-Rail Problem

Reviewed by M. L. BYERS*

STEEL RAILS: THEIR HISTORY, PROPERTIES, STRENGTH AND MANUFACTURE, With Notes on the Principles of Rolling Stock and Track Design—By William H. Sellew, Principal Assistant Engineer, Michigan Central R.R. New York: D. Van Nostrand Co. London: Constable & Co., Ltd. Cloth; 7x10 in.; pp. xvii + 559; 361 illustrations; 33 folding plates. $12.50, net.

Of late years attention has been drawn with considerable frequency to railroad accidents caused by rail failures. The author states:

> The rails of heavier section manufactured within the last few years are not giving the services they should be expected to. The fault may lie in improper methods of manufacture or in the design of the rail itself which, while suitable for the conditions existing 19 years ago, may be unfitted for the heavy wheel loads of today.

The present work, the author states, is essentially a compilation in which he has endeavored to systematize knowledge in existence on the subject and present in concise, yet clear form, the most important features of the problem.

The opening chapter devotes 70 pages to the history of the development of the rail section. The various sections in use in the past, together with the principal sections in present use in the United States and elsewhere, are fully illustrated.

The second chapter contains 69 pages on the speed and weight of modern locomotives, fast and unusual train runs, effect of counterbalance, track irregularity, rocking of the engine, flat spots in the wheels, etc. Illustrations, and the principal characteristics, of the principal types of present-day locomotives and cars are given.

The next 103 pages are devoted to the supports of the rail. Many types of steel and concrete ties are illustrated in and out of the track. Service tests are reported. Information as to the forest regions of the United States, geographic distribution of the total lumber production, the strength of various woods in their natural state and after being subjected to various treatments, railroad plantations for tie timber, size and spacing adopted for wooden ties are given. Tie-plates and screw spikes are illustrated and considerable data as to their use, especially abroad, are given. Discussions of the action of the tie, ballast and subgrade under load are summarized, and the form of the apparatus for measuring track depression illustrated.

Chapter IV (77 pages) summarizes the data bearing on the stresses in the rail and the methods which have been used in endeavoring to ascertain them. The relation between wheel load and areas of contact between the wheel and rail is stated. There is a table showing the dimensions, weights and costs of different systems of track superstructure on wooden ties. The character and causes of tire wear are illustrated and discussions abstracted. The cause and effect of flow of metal in the rail head are touched upon; the reciprocating machine for testing such flow is illustrated, and the results of tests are given. There is a description of instruments for observing the effect of train movement on track structure, and data and diagrams resulting from their use are given.

In Chapter V. (56 pages) discussions on the strength of the rail, the influence of stress and strain, repeated stresses, low temperature, etc., are taken up. The drop-testing machine for testing rails is shown by specifications and illustrations, and the results of such tests are given. The scleroscope and Amsler-Laffon instruments for measuring hardness of metal are illustrated and the principles upon which they act are explained. The Pennsylvania Steel Co.'s rotary machine for testing rail wear is illustrated.

The following chapter (137 pages) is devoted to an illustration of the processes involved in the manufacture of rails from the loading of the ore at the mines to the finishing of the product at the mill, including illustrations of modern ore docks, ore vessels, loading and unloading machines, blast furnaces of various kinds, openhearth furnaces, converters, electric furnaces, etc. The chemical composition of early and recent rails is compared. The effect of variation in different ingredients, alloys, etc., is shown by numerous tables and diagrams. Discussion of the relative desirability and availability of different processes of steel manufacture is abstracted; illustrations of the defects found in different types of ingots are given, and discussion of the causes reviewed. Data in regard to American and foreign rolling mill practice are given, and there is an abstract of discussions of the effect of variations.

The final chapter of 38 pages compares the principal rail specifications of today, of which several are given in their entirety.

The Appendix illustrates a complete set of the forms recommended by the American Railway Engineering Association for use in connection with the reporting and studying of rail failures.

The book contains a large amount of information of general interest to those concerned with railway affairs, but which is hardly of material importance in connection with the study of the problem of securing, at reasonable cost, a rail entirely fitted to present-day requirements. On the other hand, owing to the magnitude of the field, it has been impossible to cover the subject fully in any of its branches, the data given showing the general trend and the sources of the information available to those desiring to make a fuller investigation. For the purpose of affording the would-be student of steel-rail problems a general view of the entire field and guide posts to point the way to more detailed study, the book should be of very material value. It represents a large amount of painstaking investigation.

*Special Agent, Delaware & Hudson Co., 32 Nassau St., New York City.

A Treatise on the Engineering Design of Artificial Lighting

LIGHT, PHOTOMETRY AND ILLUMINATION—A Thoroughly Revised Edition of "Electrical Illuminating Engineering." By William Edward Barrows, Jr., B. S., E. E.; Professor of Electrical Engineering, University of Maine. New York and London: McGraw-Hill Book Co. Cloth; 6¼ x 9½ in.; pp. ix + 335; 192 text figures; numerous tables. $3, net.

In reviewing the earlier volume, on which the present work is based ("Eng. News," Feb. 18, 1909), we noted that a wide range of useful data had been presented in every accessible and convenient form, but that the scope of the work had not been made large enough so that the book would be of the greatest possible service to students and engineers. The author had included much matter of greatest interest only to illumination experts and physicists, to the exclusion of much that was really fundamental in the design of good everyday lighting installations. That situation seems to have been changed in the revision which has produced the new volume. Much of the material of more remote application has been abandoned and there is an interweaving of the simple ideas which fix hygienic and artistic lighting effects. There is still a great wealth of experimental data and a sufficient pursuit of theoretical discussions to suit the most avidious in that way. The time in any engineering course which can be allotted to the study of illumination problems is so small that only a part of this book becomes immediately suitable for undergraduate courses, but there is material to indicate lines of future study for the men who take up illumination work in after life.

Comparing this book to some of the others available on the same general subject it is seen that it is perhaps the most comprehensive of any now available (if we except two volumes of Johns Hopkins lectures), as it pursues the computations and theoretical discussions further than the rather more general works like Bell's "Art of Illumination," or the descriptive and somewhat pictorial work by Cravath and Lansingh, "Practical Illumination."

At the outset the author discusses the physics of what we call light. He fixes the place of light in radiation phenomena and discusses the properties known as reflection, refraction, color value, color component, etc. The constitution and reproduction of daylight is one topic taken up in particular.

After this is a chapter entitled "Luminous Equivalent of Radiation" which deals largely with physiological factors. This will be found especially interesting to beginners and of lasting usefulness to anyone who does not continuously work in the field of illuminating engineering.

So far about 15% of the volume is covered; about 33%, following, discusses photometric-laboratory apparatus and practice, starting with the primary standards of light sources and setting forth their peculiarities, advantages and drawbacks, going into the use of intermediate standards for comparative use, and later presenting the principles of photometry, with a description of the various pieces of laboratory apparatus which are better known through proved utility.

The remaining half of the book is concerned with the design of illumination installations—that is, not the architectural or mechanical features of fixtures, or the energy supply, but rather the apportionment of illumination values on surfaces to be lighted, the location and size of light-pro-

ducing units and the redistribution of flux at various angles by reflecting and refracting shades, etc. This half of the book has some less-digested and more-debatable parts than the preceding half, probably on account of the existance of conflicting ideas among illuminating experts. For instance, the author quotes Messrs. Sweet and Doane who, from an investigation of visual efficiency as affected by reflection from walls, claim it is desirable for efficiency that walls should be as dark as is consistent without being gloomy and depressing wherever close application to work in hand is to be maintained. However, it is pretty generally admitted that there is another effect entering in which seems not to have been discussed in this book. No one can apply his eyes to work in hand so persistently that it is not necessary occasionally to relieve these organs by glancing off to areas of less illumination or different color, and fatigue is usually induced if the contrast between the work and the walls is very great, although a moderate difference is advisable.

Similarly, the discussion of principles of street lighting is a presentation of the views of A. J. Sweet, who is an exponent of the idea of uniformity in pavement-illumination values, and the complete elimination of glare. There are, however, engineers of repute who hold that the function of street lighting is satisfied if freedom of collision and safety from personal molestation is secured. To this end they utilize some of the glare which would be so completely eliminated by the others. The glare then used is that specular reflection which assists in silhouetting bodies against a lighter background underneath or near the light sources as they may be variously disposed along the street.

Water Powers, Their Development and Utilization

Reviewed by EMIL KUICHLING*

DIE WASSERKRAEFTE, IHR AUSBAU UND IHRE WIRTSCHAFTLICHE AUSNUTZUNG—Ein technisch-wirtschaftliches Lehr- und Handbuch. By Adolf Ludin, Preisgekrönt von der Kgl. Akademie des Bauwesens in Berlin. Parts I and II. Berlin: Julius Springer. Cloth; 8x11 in.; pp. xvi + 763 and 637, respectively; 1087 text illustrations and folding plates. 60 Marks.

This elaborate work on the development and utilization of water powers received in its original abbreviated form the prize offered in 1909 by the Royal Academy of Engineering (Bauwesen), of Berlin, for the best treatise on the subject, and was subsequently enlarged to its present size by the author in collaboration with several other experienced engigineers. A brief introduction by Dr. Ing. Hermann Keller, Member of said academy, sets forth the great economical importance of water powers and the purpose of the academy to secure a good description of those recent power developments which might serve as models for future similar enterprises in the hilly and flat regions of Germany. He also states that in the preparation of the manuscripts entering into competition for the prize of 3000 marks, attention was to be given particularly to the economical value of each plant with reference to local conditions, and the successful author was afterward to be assisted financially in completing his work by a thorough personal examination of such plants in Germany and other European countries. On receiving this prize, Mr. Ludin made a tour in 1909 and 1910 through Germany, Austria, Switzerland, northern Italy and France, and inspected critically a large number of water-power plants. The results of all these supplementary observations, and the further studies made from the literature of the subject at home and abroad, were then submitted to the academy in the form presented in the two volumes mentioned. The introduction closes with the fervent hope that this treatise may prove useful and instructive to all who are interested in the practical development and economical utilization of water-power.

The work is divided into three main parts. Part I describes in 200 pages the modern methods of utilizing water powers, and the natural, technical and economical considerations underlying their development. Costs of the construction and operation of numerous large steam-power plants for producing and distributing electrical energy are given to serve as a basis of comparison with those of similar water-power plants, and following these data the principles of the economical utilization of water-power are set forth in full detail. A very interesting chapter is the one devoted to the computation of the most expedient magnitude of a contemplated hydraulic power development, with consideration of auxiliary steam power, water storage and association with other plants in the vicinity.

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Part II embraces 563 pages, in which good descriptions are given of the plants at Rheinfelden, Beznau, Tuilière, Schweinfurt, Blankenstein, Dörverden, Celle, Mülthal, Steinbusch and fifteen other localities in Germany, France and Switzerland. These plants involved the construction of dams and storage reservoirs of various magnitude, and the accompanying illustrations show many interesting details of location and construction. The costs and results of operation are also given along with many instructive maps, diagrams and load curves.

Part III deals with the engineering details of water-power development, and embraces the construction of fixed and movable dams, intakes, head-works, fish-ways, high dams for large reservoirs, spillways, outlets, screens, canals in earth and rock, tunnel conduits, pipes of various material, erect and inverted siphons, aqueduct bridges, gates and valves for controlling the flow of the water, air-chambers, sediment chambers, pressure regulators and devices for arresting floating driftwood and ice This portion of the second volume embraces 500 pages, and the remaining 109 pages are devoted to the design and construction of power houses, screening racks, outlets, transmission-line supports, valuable statistical data, and some details of spillways and dams. To the construction and theoretical design of turbines relatively little space is given, as the author refers for such information to various special treatises on that subject, but this omission is amply compensated by many critical descriptions and illustrations of turbines in place.

The second volume closes with an excellent index and an abbreviated list of the technical literature on water-power consulted by the author, and it is gratifying to find that this list embraces most of our American engineering publications and journals. The subjects dealt with by the author are numerous and important, and the temptation to refer at greater length to his treatment of some of them is strong, but as space therefor is not now available, it must suffice to say that Mr. Ludin's work has been very well done, and that it deserves to occupy a prominent place in the library of every hydraulic engineer.

THE CONCRETE HOUSE AND ITS CONSTRUCTION—By Maurice M. Sloan. Philadelphia: Association of American Portland Cement Manufacturers. (Secretary, Percy H. Wilson, Land Title Building.) Cloth; 6x9 in.; pp. 224; illustrated. $1.

The concrete dwelling house is a comparative novelty and, like all novelties, subject to considerable suspicion on the part of those who might or should use it. It is largely to allay that suspicion and to encourage the prospective home builder to use concrete that the Association of American Portland Cement Manufacturers has published this very attractive book.

In one regard it is most successful. We know of no other similar work that gives so fully or clearly the many small but necessary details of fittings and connections of concrete house construction, details that in many ways are quite different from those required in the larger types of concrete construction. It provides, too, very satisfactory chapters on structural design and construction, containing the required information in simplest terms but sufficiently complete. While the author is evidently not quite clear whether he is addressing the builder or the owner, and so confuses the very different instruction the two should have, it is nevertheless the fact that he has succeeded in his intention "to make clear the advantages of concrete in the construction of dwellings."

In some other respects, however, the author has not been so fortunate. It is quite probable that the average prospective builder has no doubt about the many structural and fireproof qualities of concrete construction. What he is worried about—and his worry is based on the experience of many—is the appearance and cost of a concrete house. It is a well known fact that the average concrete house is not good to look upon and is very expensive. It would appear to be the duty of the author of such a book as this to try to allay this feeling of distrust by the illustration and description of some of the occasional houses where a happy combination of architect and builder has produced a good looking concrete house which costs little more than houses of the older and less durable type. It is perhaps a matter of taste, but it seems to us that Mr. Sloan could have been more happy in his selections of examples of the architectural possibilities of concrete. With the exception of a very few, the houses illustrated are lacking in the something that makes the passer-by wish he had built his house that way. The author has not quite succeeded in steering a straight course between the gingerbread of over ornamentation and the "futurist" style that "would have concrete frankly stand for what it is"—including hair cracks and form marks.

As to cost, the author states that "the prevailing notion that the cost of a concrete house is far in excess of other materials is absolutely wrong," but the reader looks in vain for figures bearing out this statement.

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A Notable British Survey of Municipal Ownership

PRINCIPLES AND METHODS OF MUNICIPAL TRADING—By Douglas Knoop, Lecturer on Economics in the University of Sheffield; Late Langton Fellow of the University of Manchester. London: Macmillan & Co., Ltd. Cloth; 5x9 in.; pp. xvii+409; $3.25 (10s.), net.

Mr. Knoop's book differs materially from the many others on the same general subject in that it deals with the principles and methods, as well as with the advantages and disadvantages, of municipal trading—or ownership. As befits a book which has grown from a successful effort to win the Warburton Essay Prize (1906) at the University of Manchester, the book is judicial rather than partisan in character. Here and there the author states what is and what is not a fit subject for municipal ownership and he is continually bringing out weak points in British municipal trading enterprises—which enterprises are more varied and more common than with us.

The scope, development and extent of municipal trading are first dealt with. Questions of management and financial aspects are then taken up. This leads naturally to a consideration of "Selling Policies," which is followed by "The Labor Policy." The author next sets forth "The Results of Municipal Trading," and then presents a 20-page "Summary and Conclusion." Appendixes consist of a brief bibliography and tramway and other municipal ownership statistics.

The specific data, which are extensive, are drawn from Great Britain and Germany, chiefly the former. There are a few meager references to the United States. A better aquaintance with conditions in this country, especially as regards state control, might have broadened the author's opinion as to the best ways of meeting some of the British problems which he discusses; but we do not offer this as a serious criticism.

The chapter on "Results" was apparently a disappointment to the author himself, because of lack of the right sort of statistical data, lack of uniformity in such statistics as are available, failure to distinguish properly between capital and operating expenditures and other weaknesses or inaccuracies in accounting practice. The author deserves credit for making the best out of deficient material and for his ingenuity in weighing financial results from different viewpoints. He is also entitled to commendation for recognizing the consideration which should be given to local conditions in such a study; for instance, in taking into account whether the local policy is to supply a given service at low rates and make up deficiencies from "the rates" (general taxation) or to make a profit to be applied "in relief of rates." Either of these policies may be wrong, according to one's viewpoint, but the author rightly urges that it is the wrong policy rather than the result which follows that should be condemned.

The final conclusion of the author, as expressed in the very last words of his book, is that after many years of study, but subject to change when more and better data are available, "municipal trading in itself is undesirable, but that nevertheless a certain amount of it may be justified, owing to the fact that in certain industries private enterprise may give even less satisfactory results than municipal enterprise." Elsewhere in the chapter of "Summary and Conclusion" we find the following more explicit statement of what industries may better serve the people under public rather than private ownership:

> These industries are such as have a strong tendency to become local monopolies, which is generally true of tramways, water, gas and electricity supply undertakings. . . . There can be no general rule on the subject, each individual case must be considered on its own merits.

It will be seen that, in the author's opinion, the much debated question of municipal ownership is one of expediency, and that in general he considers it expedient for cities and towns to own and operate monopolistic or noncompetitive undertakings, while, "with one or two small exceptions, the management of competitive undertakings by municipalities is strongly to be deprecated." These exceptions include "a small amount of experimental housebuilding, where such is necessary to form a basis for new and better building regulations, or for town-planning schemes, and the provision of savings banks where suitable facilities for the safe keeping of small sums of money are not provided by the central government or by private undertakings of high-class standing."

Before dismissing the book we wish to revert again to the benefit which the author and his book might have derived from a fuller consideration of American practice. He makes it clear that the British central authorities lay down the conditions under which municipal trading or ownership may be entered upon, but he does not cite as worthy of consideration and possible adoption the practice of some American states (of course, not the Federal government) in controlling the character of the "trading" service, the rates charged and the division of the burden among private consumers and the general public, or city as a whole. It is true that outside Wisconsin as a state and the sanitary aspects of public water-supply, this control is confined chiefly to private companies (which we call public service or public utility corporatons); but state regulation has of late years weakened some of the strongest of the earlier arguments for municipal ownership of monopolistic or non-competitive services.

The author and his readers might also have profited from a consideration of the American theory and practice, already mentioned casually, of dividing the cost of the various "trading" services between the private consumer and the city as a whole. This eliminates all those questions as to "subsidies from the rates" (taxes) and "contributions to the relief of the rates," which together occupy considerable space in Mr. Knoop's book. We do not mean to convey the idea that every city in the United States, or even a large percentage of them, makes a clear-cut division of this sort; but the principle seems to have gained more recognition here than in England, and where it is not observed it is more through poor accounting than deliberate intention.

Finally, we take pleasure in commending Mr. Knoop's book as being on the whole the broadest in general scope and the most impartial in treatment of any of the many books on municipal trading or ownership which have yet appeared in the English language. Its value, as we have already indicated, would be increased if its geographical scope were broadened—not so much in the way of statistics as in general principles and practice. Limited as the book is chiefly to Great Britain it would probably gain in forcefulness, as it certainly would in readability, if a considerable reduction were made in the amount of statistical data and analysis with which the book abounds. To some, however, these features will be strong points in favor of the book.

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TESTS OF REINFORCED-CONCRETE BUILDINGS UNDER LOAD—By Arthur N. Talbot and Willis A. Slater. Bulletin 64. Urbana, Ill.: University of Illinois. Paper; 6x9 in.; pp. 104; illustrated.

The testing under load of the floor systems of reinforced-concrete buildings, by measuring the elastic deformation of the steel and concrete members, was first tried in the Fall of 1910 by members of the Engineering Experiment Station of the University of Illinois. Since that time, nearly a dozen full-sized test panels have been experimented upon in the same fashion, all under the general supervision of members of the same experiment station. In past issues of "Engineering News" rather lengthy abstracts of these tests have appeared, notably in the issue of Apr. 18, 1912, p. 718. Some of the engineering societies, also, have published in their proceedings abstracts of one or more of the tests, but there has not appeared, until the above noted bulletin, any full account of the experiments.

This bulletin is devoted particularly to a description of three of these tests and to a lengthy and complete description of the technique of the testing. The method of testing is so different from the ordinary load tests that a knowledge of the technique is quite necessary if one is to attempt similar tests. On this account, the bulletin is of more interest to one who is contemplating making such tests than to the engineer who wishes to get some enlightenment on the performance of certain types of reinforced-concrete structures, but a close reading of the data presented will be of undoubted usefulness to the latter.

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THE PURIFICATION OF PUBLIC WATER-SUPPLIES—By George A. Johnson. Water Supply Paper 315. Washington, D. C.: United States Geological Survey. Paper; 6x9 in.; pp. 84; illustrated.

The characteristics of water-supplies from various sources are outlined, some typhoid statistics in relation to water-supply given, slow sand and mechanical filtration described and the cost of each given for a number of plants, besides which hypochlorite and water softening treatment are taken up. A few well chosen illustrations, mostly halftones, are presented. The author states that delay in publication (manuscript submitted in July, 1911), has rendered some of the text "behind the most approved practice of today," but, as he truly says, only "in some relatively unimportant respects." The

paper will be of value for city officials and others wishing a simple statement of the principles and practice of filtration, for whom it was specificially designed. Engineers will also welcome it as a concise review of the subject, written by an authority on water treatment.

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A Notable Book on Electrical Machine Design

Reviewed by COMFORT A. ADAMS*

ELECTRICAL MACHINE DESIGN—The Design and Specification of Direct and Alternating Current Machinery. By Alexander Gray, Assistant Professor of Electrical Engineering McGill University, Montreal, Can. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii+528; 317 text illustrations. $4, net.

The work of the engineer whether it be concerned with the design of a dynamo, of a power plant, or of a bridge, consists in the application of scientific principles to the attainment of certain practical ends which usually involve economic or commercial considerations. In most cases the phenomena involved are so complex, and the number of variables so great, that an exact scientific solution of the problem is impossible. Hence the resort to empirical short cuts. In the early days of dynamo design these short cuts involved the neglect of many factors either considered of negligable importance or wholly overlooked, and one of the chief assets of the designer was the mass of empirical information and data gathered in the course of his work. It was during these comparatively early days (not many years ago) that one of the authorities on the subject made the much quoted statement that Dynamo Design is an art rather than a science.

But the modern designing engineer must take quite a different attitude toward his work if he is to excel. Many of the computations now regularly made by the higher-grade designers would have been ridiculed ten years ago as "academic," and "useless refinements." The rational is rapidly displacing the empirical, and Professor Gray's is the first comprehensive book, printed in English, which is at all satisfying to those who want to know the reason why, and at the same time eminently practical.

The first impression one gets in glancing through the book is the immense amount of ground covered in the 511 pages of text. Not only is the variety of machines treated considerable, including Direct-Current Machines, Synchronous Generators and Motors, Polyphase Induction Motors, and Transformers, but each type is considered in an unusually exhaustive fashion. For example, under D.-C. Machines there are the following chapters: Magnetic Induction; Armature Winding; Construction of Machines; Insulation; The Magnetic Circuit; Armature Reaction; Design of Magnetic Circuit; Commutation, Efficiency and Losses; Heating; Procedure in Armature Designs; Motor Design and Ratings; Limitations in Design; Interpoles; and Specifications. Under Induction Motors are considered such practical topics as "Noise and Deadpoints." in addition to the subjects ordinarily treated. Under Insulation, the potential gradient is treated in a rational practical manner, and under Heating, the temperature gradient in copper and in insulating materials is subjected to computation. These subjects are usually noticeable by their absence.

It is thus not strange that there are some places where compactness is carried too far, although the reviewer was continually surprised at the skill displayed in getting reasonably satisfactory explanations and demonstrations into small compass. It is to be regretted that more references were not given for the benefit of those desiring a more thorough understanding of the subject.

There is so much to commend and the book is so full of interesting considerations commonly overlooked that it is only possible to point out what seems to the writer to be the most distinguishing characteristic, namely, the relatively rational order of procedure and the use of computations rather than empirical data. It gives the student a feeling of confidence to realize that he is not wholly dependent upon canned information as to "precedent" and "good practice."

There are several omissions and apparent inaccuracies, but these are for the most part of minor importance. Some of the more prominent follow:

No mention is made of interpole leakage, of its magnitude or of its importance, and no intimation is given as to the desirability of an inductive shunt for the adjustment of the interpole excittion.

In computing the tooth-tip reactance of Alternators (page 223) the flux per ampere inch in each belt is charged in proportion to the r.m.s. value of the current during the corresponding portion of the cycle, whereas since the reactance volts is the final end of the calculation, it is $\frac{di}{dt}$ and its r.m.s. value that are significant.

On page 358 no reason is given for multiplying the Carter coefficients for stator and rotor together rather than averaging them.

On page 389 it is stated that the number of (wound) rotor and stator slots per phase per pole must each be a whole number. The only requirement of "balance" is that the total number of slots in (wound) rotor or stator shall be a multiple of the number of phases. There are in fact certain advantages arising from a fractional number of slots per phase per pole, the only disadvantage being the greater chance for mistake in the original connecting up the coils.

In general there is too much concrete information in proportion to the explanations, and the limitations given for the various constants are too narrow in many cases. The design of a standard type of machine is made too easy from the standpoint of a text for students (whether in or out of college). It is not sufficient to supply the opportunity to think; the average student will not think unless considerable pressure is brought to bear, and the chief value of college instruction in dynamo design is to cultivate the habit of thinking, of demanding the reason why.

It is to be regretted that the metric system was not used in at least an auxiliary capacity.

The book seems to be such a distinct step in advance of the otherwise available literature in English on this subject that the reviewer does not wish to lay undue stress on minor details. The illustrations are for the most part clear and to the point, and the typography is excellent.

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SYNDICALISM, INDUSTRIAL UNIONISM AND SOCIALISM—By John Spargo. New York: B. W. Huebsch. Cloth; 5x8 in.; pp. 241. $1.25, net.

An analysis of Syndicalism by a socialist who believes in bringing about the socialistic state through education and order rather than anarchy, and who also believes that treachery to those without the ranks will later be followed by treachery between factions within could hardly fail to be interesting, especially when written by John Spargo. The author deals with the origin, history and philosophy of syndicalism and with its accompaniment of sabotage or economic injury to the capitalists by one means or another. The Relation of Syndicalism to Socialism is discussed—naturally to the advantage of the latter. The book is well worth reading, especially by all who are likely to have to meet labor problems.

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STEEL; ITS SELECTION, ANNEALING, HARDENING AND TEMPERING—By E. R. Markham. Fourth edition, fully illustrated. New York: Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 367; 168 text illustrations. $2.50, net.

Earlier editions of this book, under the title "American Steel Worker," were favorably reviewed in our issues of June 18, 1903, and Nov. 15, 1906. There is known, of course, to have been a great progress in development of special steels for automobile construction and the author has taken opportunity to include a little matter on the new products. He complains, however, of the secrecy which manufacturers throw around their complicated alloys. The book is avowedly only a text on practical manipulation.

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Studies of "County Government," by a number of writers and from many viewpoints, fill 275 pages of the May "Annals of the American Academy of Political and Social Science" (Philadelphia; $1 a number). The subject is one which deserves serious consideration, since public attention is fixed, for the most part, on the cities and towns or else on the states and the nation, leaving the counties almost out of consideration except by the politicians and their coworkers. The symposium just noted might well have included separate papers on county public works and their administration. The general plan of the symposium was outlined by H. S. Gilbertson, of the National Short Ballot Organization, New York City, and the symposium was under the editorial direction of Prof. Clyde L. King, of the University of Pennsylvania, Philadelphia.

Pumping Machinery

Reviewed by NICHOLAS S. HILL, JR.*

MODERN PUMPING AND HYDRAULIC MACHINERY, as Applied to All Purposes, with Explanation of the Theoretical Principles Involved, Construction, Working and Relative Advantages—Being a Practical Handbook for Engineers, Designers and Others. By Edward Butler, M. Inst. M. E., author of "Carburettors, Vaporisers and Distributing Valves," "Evolution of the Internal Combustion Engine," etc. Philadelphia, Penn.: J. B. Lippincott Co. London: Charles Griffin & Co., Ltd. Cloth; 6x9 in.; pp. xvi + 473; 345 illustrations. $5.50, net.

The author of this English publication says the book is intended to be useful to "practical engineers, designers, and others engaged either in the construction or application of pumping and hydraulic machinery." This is certainly a wide field of usefulness and one difficult to treat comprehensively in a volume of even 460 pages. It must be said that much has been accomplished. The character of the book is principally descriptive. It is illustrated with an abundance of well chosen cuts and the subject is presented in a very readable manner. The products of English and Continental builders form the greater number of subjects described, but this does not detract greatly from its value to the American reader. Many principal types of American machines find their proper place in the treatment, the whole work being a very comprehensive and analytical review of the present state of the art of building and operating hydraulic machinery.

It is doubtful if the designer will find that quantitative information which is helpful in his work in more than a small amount except in certain chapters. Dimensions of parts which have been found in practice to be correct, or formula derived therefrom are a most useful part of any book on design, but such information is very meager in this volume. The designer, and many others, should, however, profit by the mass of information relating to features of design and conditions of operation of all classes of hydraulic machinery which are in successful use today. Historical matter is presented in a very few pages.

Nineteen chapters are devoted to a discussion of all the more common forms of steam-driven pumps, direct-acting pumps directly driven by gas engines, air-lift and air-displacement pumps, deep-well pumps, ejectors, fire-engine pumps, rotary pumps, centrifugal pumps and other special forms of pumps. Besides a consideration of about all the known forms of pumps in common use, there are chapters on boring appliances for wells, appliances for raising petroleum from deep wells, gas-displacement pumps, hydraulic transmitters, waterwheels, hydraulic turbines and pipe-line phenomena. It is quite evident that it is impossible to give in 460 pages more than general information about all of these subjects. A remarkable amount of information is, however, crowded into the space, and a careful reader may absorb a large fund of general information on all of these subjects and a considerable amount of specific information on some of them. The advantageous and peculiar features of all classes of pumps and other hydraulic machinery are well and comprehensively stated.

Performances, expected and attained, and the adaptability for various purposes is woven into the descriptive matter and also discussed separately in an interesting manner and a large amount of such important matter is to be found.

The work will undoubtedly prove a valuable addition to the literature of the subject, especially as a source of information relating to types and service and to a certain extent as furnishing information on which to base design.

CASSELL'S REINFORCED CONCRETE—A Complete Treatise on the Practice and Theory of Modern Construction in Concrete Steel. Edited by Bernard E. Jones, Editor of "Building World" and Albert Lakeman, M. C. I. Honors Medalist in Building Construction. London and New York: Cassell & Co., Ltd. Cloth; 8x11 in.; pp xx+398; 171 illustrations and 500 diagrams and working drawings. $5, net.

As a rule, collaboration in a book of this sort is not very successful because the various authors are apt to overlap, and not infrequently to contradict each other. In this particular case, however, the editing has been quite carefully done and the separation of the subject matter into distinct fields has resulted in a clear-cut treatment, with the additional advantage of having a specialist in charge of each branch. The chief contributors and the different subjects treated are as follows: Frank C. Gatehouse, portland cement; Thomas Potter, concrete; A. B. Searle, concrete, cement, waterproofing, etc.; E. L. Rhead, steel; Albert Lakeman, theory; V. F. Hyde, erection forms; F. P. Barker, forms; G. E. Hardy, architectural treatment; A. F. Jennings, paving; W. H. Brown, estimating; and B. E. Jones, editor-in-chief, introduction, history, example, etc.

The book is distinctly British in that it lays especial emphasis on the matter of estimating, which is the special province of the "quantity surveyor" in Great Britain, and upon the differences in the various systems which control the concrete industry in that country. Aside from these localisms, and a peculiar kind of notation, the book would serve admirably for American use. It is simple in its treatment and quite comprehensive, particularly in the description of various kinds of machinery used in concrete construction. It is illustrated very extensively with photographs which are of considerable interest and with line drawings of structures, which, as usual in English books on concrete, are quite valueless on account of their lack of detail.

THE SOCIAL CENTER—Edited by Edward J. Ward, Adviser in Civic and Social Center Development, University of Wisconsin. [National Municipal League Series.] New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. x + 359. $1.50, net.

The main thesis of this book is that every public school house should be not only a polling place, but also a meeting place for all citizens, old and young. The author says that members of city, state and national legislatures deliberate before they vote and have fit meeting places for their deliberations, but that the members of the great electorate (who are rapidly becoming direct legislators as well) have no common meeting place for discussions of public questions, free from domination by some political party or religious sect or other division of the great body politic. Indeed, they rarely have fit voting places, even. He would place polling places in public school buildings, and also provide there suitable halls for meetings of both adults and youth, as well as branches of public libraries. The meetings held in these school buildings would have to do with all phases of citizenship, recreation and education. A civic and social secretary would be provided for each building. Examples of social center work in a number of cities are given. The book is an extension of the general principles set forth in "The Wider Use of the School Plant," noted in our issue of June 15, 1911.

The economic waste due to the general restriction of the use of school buildings to a few daylight hours for 180 days in the year, while at the same time providing still other public buildings, many of which are used far less of the time, is a subject which should have been given wide attention long before this. In addition, there are other and perhaps even stronger reasons for making the school house the civic and social center of each neighborhood. These reasons are set forth at length—often at unnecessary length—in the book before us, which deserves a wide circulation.

MORTALITY STATISTICS FOR 1911—General Death Rates, Specific and Standardized Death Rates, Infant and Child Mortality, and Causes of Death. Bulletin 112. Washington, D. C.: Bureau of the Census. Paper; 9x12 in.; pp. 142.

It is a pleasure to note that 63.1% of the estimated mid-year population of the United States were embraced in the death-registration area. The total population involved is placed at 59,275,977 and the death rate from all causes was 14.2 per 1000. This is the lowest death rate for the registration area ever yet recorded and is a notable decline from the 17.8 rate of 1900—though it should be noted that the registration area has been materially extended since 1900. The typhoid death rate per 100,000 was 21 per 100,000 in 1911, as compared with 25.6 for the five years 1906-10 and 32 for 1901-6.

INSPECTION OF EUROPEAN PORTS—By Joseph A. Conry. Boston, Mass.: Directors of the Port of Boston. Paper; 6x9 in.; pp. 28.

Concise notes on 16 European ports are here presented in readable form, followed by a few paragraphs of "conclusions" applied to Boston. The ports inspected were London, Bristol, Cardiff, Grimsby (England's latest port' Hull, Newcastle Leith, Glasgow, Belfast, Dublin, Liverpool, Manchester, Antwerp, Rotterdam, Bremen and Hamburg.

Articles and notes on City Planning form a considerable part of the contents of the "Journal of the American Institute of Architects" (The Octagon, Washington, D. C.; 50c. per number) for June. The opening article is "A City-Planning Program," by F. L. Olmsted, and address at the recent City Planning Congress at Chicago, Ill.

A new edition of "Defunct Municipal Lighting Plants" has been issued as a 55-page pamphlet (The Municipal Ownership

*Consulting Engineer, 100 William St., New York City.

Publishing Co., New York City; 25c.). It consists of from a few lines to a couple of pages or more regarding a considerable number of electric-lighting plants reported as having been sold or leased to private companies or else shut down. The allegations of fact and expressions of opinion are designed to prove that municipal ownership is universally and inevitably a miserable failure.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ABSTRACT OF THE THIRTEENTH CENSUS OF THE UNITED STATES, Taken in 1910, with Supplement for New York. Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 795; illustrated.

AMERICAN WOOD PRESERVERS' ASSOCIATION—Proceedings of Ninth Annual Meeting, Jan. 21-23, 1913. Baltimore, Md.; Secretary, F. J. Angier, Mt. Royal Station. Paper; 5x8 in.; pp. 478; illustrated.

CHICAGO CIVIL SERVICE COMMISSION—Analysis of Employment and Departmental Organization Charts, March, 1913; and Outline Report of Work of the Efficiency Division, 1909-1912. Chicago, Ill.: R. A. Widdowson, Secretary. Paper; 7x10 in.; pp. 99.

COMPUTATIONS FOR MARINE ENGINES—By C. H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. v+209; 51 text figures. $2.50, net.

THE DESIGN AND CONSTRUCTION OF STEAM TURBINES—A Manual for the Engineer. By Harold Medway Martin, author of "Statically Indeterminate Structures and the Method of Least Work." London, England: "Engineering." New York: Longmans, Green & Co. Cloth; 8x11 in.; pp. viii+372; 523 illustrations, including 24 folding plates. $8.50, net.

THE DEVONIAN AND MISSISSIPPIAN FORMATIONS OF NORTHEASTERN OHIO—By Prof. Charles S. Prosser. Columbus, Ohio: Geological Survey of Ohio. Bulletin 15. Cloth; 6x9 in.; pp ix+574; illustrated.

DIE ELEKTRISCHEN STADTSCHNELLBAHNEN DER VEREINIGTEN STAATEN VON NORDAMERIKA, Anlage, Bau und Betrieb der Stadtbahnen in New York, Boston, Philadelphia und Chicago. By F. Musil. [Sonderandruck aus dem Organ für die "Fortschritte des Eisenbahnwesens." 1913.] Wiesbaden, Germany: C. W. Kreidel. Paper; 9x12 in.; pp. 50; 37 text illustrations and 6 folding plates. 3.60 Marks.

AN ELEMENTARY TREATISE ON CALCULUS—A Text-Book for Colleges and Technical Schools. By William S. Franklin, Barry MacNutt and Rollin L. Charles, of Lehigh University. South Bethlehem, Penn.: The Authors. Cloth; 6x8 in.; pp. ix+291. $2.

FOREST PARK RESERVATION COMMISSION OF NEW JERSEY—Eighth Annual Report for Year Ended Oct. 31, 1912. Trenton, N. J.: Alfred Gaskill, Secretary. Paper; 6x9 in.; pp. 81, illustrated.

GAS ANALYSIS—By L. M. Dennis, Professor of Inorganic Chemistry, Cornell University. New York: The MacMillan Co. Cloth; 5x8 in.; pp. xvi+434; 110 text illustrations. $2.10, net.

GEOLOGICAL SURVEY OF NEW JERSEY—Annual Administrative Report of State Geologist Henry B. Kümmel (Trenton, N. J.) for 1912, including a Second Report on Shark River Inlet by C. C. Vermeule, Consulting Engineer, and a List of New Bench Marks. Cardboard; 6x9 in.; pp. 103.

ILLINOIS COAL MINING INVESTIGATIONS—Preliminary Report on Organization and Method of Investigations. Urbana, Ill.: "Coal Mining Investigations," University of Illinois. Paper; 6x9 in.; pp. 71; illustrated.

ILLINOIS HIGHWAY COMMISSION—Fourth Report, for Years 1910, 1911 and 1912. Springfield, Ill.: A. N. Johnson, State Engineer. Paper; 6x9 in.; pp. 345; illustrated.

ILLINOIS STATE MINING BOARD—Annual Coal Report for Year Ended June 30, 1912. Springfield, Ill.: Martin Bolt, Chief Clerk. Cloth; 6x9 in.; pp. xii+423.

ILLINOIS WATER SUPPLY ASSOCIATION—Proceedings of Fifth Meeting, Mar. 11-12, 1913. Urbana, Ill.; Secretary, Edward Bartow, University of Illinois. Cloth; 6x9 in.; pp. 277; illustrated.

LAKE SUPERIOR IRON ORE ANNUAL FOR 1913—Official Figures on Shipments by Mines, Ranges and Ports, together with Complete Statistics Bearing on the Lake Superior Ore Movement since 1844; Ore Prices, Receipts at Lower Lake Docks. Cleveland, Ohio: Penton Publishing Co. Leather or cloth; 6x9 in.; pp. 71; illustrated. Leather, $2; cloth, $1.

LEHRBUCH DES HOCHBAUES—Edited by Esselborn. In Two Parts. Vol. 1, Steinkonstruktionen und Grundbau. Holzkonstruktionen. Eisenkonstruktionen. Eisenbetonkonstruktionen. Veranschlagen. Baufuhrung. Beleuchtungs- Heizungs- und Andre Anlagen. By E. Beutinger, B. Kossmann, G. Ruth, H. Steinberger, R. Weder. Paper; 8x11 in.; pp. xxiii+897; 2500 text figures. 36 Marks.

MINERAL INDUSTRIES AND GEOLOGY OF VERMONT—Report of State Geologist George H. Perkins (University of Vermont, Burlington, Vt.) for 1911-1912. Cloth; 6x9 in.; pp. 269; illustrated.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK—Proceedings for 1912. New York: The Municipal Engineers, 29 W. 39th St. Cloth; 6x9 in.; pp. 362; illustrated.

THE MODERN WARSHIP—By Edward L. Attwood, M. Inst. N. A., Royal Corps of Naval Constructors. [Being one of the Cambridge Manuals of Science and Literature.] Cambridge, England: The University Press. New York: G. P. Putnam's Sons. Linen; 5x7 in.; pp. vii+146; illustrated. 40c. net.

NEW YORK STATE DEPARTMENT OF LABOR (Albany, N. Y.)—Annual Report of Commissioner of Labor for Year Ended Sept. 30, 1912; Annual Reports of Bureaus of Factory Inspection, Mercantile Inspection, Mediation and Arbitration for Year Ended Sept. 30, 1911, Vol. I; Annual Report of Bureau of Labor Statistics for Year Ended Sept. 30, 1911, Vol. III, Part II. Cloth; 6x9 in.; pp. 383, 641 and 601, respectively.

ORE DEPOSITS OF THE HELENA MINING REGION, MONTANA—By Adolph Knopf. Washington, D. C.: United States Geological Survey. Paper; 6x9 in.; pp. 143; illustrated.

PORTLAND CEMENT MATERIALS AND INDUSTRY IN THE UNITED STATES—By Edwin C. Eckel. Washington, D. C.: United States Geological Survey. Paper; 6x9 in.; pp. 401; illustrated.

PRINCIPLES OF IRRIGATION ENGINEERING: Arid Lands, Water Supply, Storage Works, Dams, Canals, Water Supply, Storage Works, Dams, Canals, Water Rights and Products—By Frederick Haynes Newell, Director, and Daniel William Murphy, Engineer in Charge of Drainage, United States Reclamation Service. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii+293; 53 illustrations. $3, net.

PROPOSED REGULATIONS FOR THE DRILLING OF GAS AND OIL WELLS—By O. P. Hood and A. G. Heggem. Washington, D. C.: Bureau of Mines. Paper; 6x9; illustrated.

PROVINCE OF ONTARIO HYDRO-ELECTRIC POWER COMMISSION—Fifth Annual Report for Year Ended Oct. 31, 1912. Toronto: W. W. Pope, Secretary. Paper; 6x9 in.; pp. 255, illustrated.

PUBLIC SERVICE COMMISSION, FIRST DISTRICT, STATE OF NEW YORK—Report for Year Ended Dec. 31, 1911. Vol. II, Statistics of Transportation Companies for the Year Ended June 30, 1911. Compiled by George P. Watkins, Assistant Chief Statistician. New York: Bureau of Statistics and Accounts. Cloth; 6x9 in.; pp. 771.

"ROSE TECHNIC" AUTHOR AND SUBJECT INDEX, 1891 to 1912. Terre Haute, Ind.: Rose Polytechnic Institute. Paper; 8x11 in.; pp. 30.

SOLUTION OF RAILROAD PROBLEMS BY THE SLIDE RULE—By E. R. Cary, M. Am. Soc. C. E., Professor of Railroad Engineering and Geodesy, Rensselaer Polytechnic Institute. New York: D. Van Nostrand Co. Cloth; 4x6 in.; pp. ix+136; 43 text figures. $1, net.

STATISTICAL ABSTRACT OF THE UNITED STATES—Thirty-fifth Number, 1912. Washington, D. C.: Bureau of Foreign and Domestic Commerce. Cloth; 6x9 in.; pp. 836.

STEEL DESIGNING—Being "Structural Engineering," Book III. By Edward Godfrey, M. Am. Soc. C. E., Structural Engineer, Robert W. Hunt & Co.; author of "Steel and Reinforced Concrete in Buildings," "Some Mooted Questions in Reinforced Concrete Design," etc. Pittsburgh, Penn.: The Author, Monongahela Building. Leather; 4x7 in.; pp. 492; numerous text figures and drawings. $2.50

ST. LOUIS BUREAU FOR REVISION OF ACCOUNTS AND METHODS—Report of Apr. 15, 1913. St. Louis, Mo.: B. J. Taussig, Comptroller. Paper; 9x12 in.; pp. 26; illustrated.

TESTIMONY AND REPORT ON THE LIVINGSTONE CHANNEL [DETROIT RIVER]—Washington, D. C.: International Joint Commission of the United States and Canada. Two Pamphlets. Paper; 6x9 in.; pp. 225 and 18, respectively.

TRADE UNIONISM, UNEMPLOYMENT, WAGES, PRICES AND COST OF LIVING IN AUSTRALIA, 1891-1912. [Labor and Industrial Branch Report No. 2.] Melbourne, Australia: Commonwealth Bureau of Census and Statistics. Paper; 6x9 in.; pp. 77.

UNITED STATES GEOLOGICAL SURVEY—Complete lists, to date, of serial publications (topographic maps excepted) of the Survey. Washington, D. C.: George Otis Smith, Director. Paper; 6x9 in.; pp. 124.

WISCONSIN RAILROAD COMMISSION—Opinions and Decisions. Vol. VII, June 15 to Sept. 23, 1911. Vol. VIII, Sept. 27, 1911, to Mar. 12, 1912. Compiled by J. M. Winterbotham, Secretary, Madison, Wis. Cloth; 6x9 in.; pp. xvii+887 and xxiii+863.